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This report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U. S. Environmental Protection Agency. This report examines the changes in cultural practices following cancellation of pesticides registrations under FIFRA. The pesticides and former use sites in the study are DBCP as a post-emergent herbicide on California cole crops, and 2, 4, 5-T for conifer release in the Northwest and the Southeast. Since the cancellation of pesticides registrations under FIFRA, new developments have alleviated the projected impacts of the regulatory actions. The report concludes with a brief discussion of the factors contributing to the new developments.

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# LONG-TERM IMPACTS OF THE CANCELLATION OF PESTICIDE REGISTRATIONS: THREE CASES

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## Disclaimer

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The contents are essentially as received from the author. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency. Mention, if any, of company, process, or product names is not to be considered as an endorsement by the U. S. Environmental Protection Agency.

# ABSTRACT

Changes in cultural practices following cancellation of pesticide registrations under FIFRA are examined. The pesticides and former use sites studied are DBCP as a nematicide in California vineyards, nitrofen as a post-emergent herbicide on California cole crops, and 2,4,5-T for conifer release in the Northwest and the Southeast. It is found that new developments since cancellation have alleviated the projected impacts of the regulatory actions. A brief discussion of the factors contributing to the observed innovative activity concludes the paper.

# I. INTRODUCTION

The U.S. Environmental Protection Agency has been charged with the responsibility of regulating the use of pesticides in the U.S. At times this responsibility requires removal of specific chemicals from the market. This paper examines the consequences of the removal of three products from the market. Former use-sites of nitrofen, dibromochloropropane (DBCP), and 2,4,5 trichlorophenoxy acetic acid (2,4,5-T) prior to their removal from use are examined. The current cultural practices are documented and the causes for these changes are discussed.

Part II of the paper provides background information on the regulatory environment that the EPA operates in, and on the procedure used to select the cases studied. The DBCP, nitrofen, and 2,4,5-T cases are examined in the following three parts. In Part VI, elements affecting the rate of innovation in pest management are discussed. Part VII concludes the paper.

## II. BACKGROUND

### 1. The Regulatory Environment

The primary federal statute regulating pesticides is the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA prohibits the distribution and sale of any pesticide not registered with the Administrator of the Environmental Protection Agency (EPA) and gives the Administrator the enforcement authority to accomplish the provisions of the act. These powers include prescribing standards for registration, cancellation and suspension of registration, registration and inspection of facilities which produce pesticides, and regulation of the use and disposal of pesticides.

The amendments to FIFRA in 1972 and 1975 altered the registration process so that the EPA's decision to register a pesticide involves a comparison of the social costs and benefits of the pesticide. In addition, the 1972 amendment directed the EPA to review the registration of all pesticides registered prior to 1972, and to reregister only those that do not cause unreasonable adverse effects on human health or the environment. The 1975 amendment directed the EPA to also take the impact on agriculture into account when reviewing the registration of a pesticide. This was in response to the perception that the review process was placing too much emphasis on the costs and not enough on the benefits of pesticide use.

In response to the 1972 and 1975 amendments to FIFRA, the EPA created the Rebuttable Presumption Against Registration (RPAR) process, known as the Special Review process since 1983. A Special Review is the administrative procedure used by the EPA to review the registration of a problem pesticide and determine what regulatory action is appropriate. The Special Review process can be broken up into several segments.

The first step involves a determination at the Assistant Administrator level that a Special Review of the pesticide is appropriate. The decision is triggered by significant evidence of potentially unreasonable adverse effects on man or the environment. The Administrator has the option of either issuing a notice of intent to cancel the registration, a registration suspension order, or an emergency suspension order. The suspension orders are issued when the continued use of the pesticide poses an imminent hazard to man or the environment. A suspension order leads to an expedited hearing to determine the imminence of the danger. If the hearing concurs with the Administrator's conclusion, the sale, distribution, and use of the pesticide is immediately halted. An emergency suspension order is issued when the continued use of the pesticide is considered so hazardous that the delay of holding a suspension hearing is unacceptable. In this case, the sale, distribution, and use is immediately halted. When only a notice of intent to cancel is issued, the pesticide continues to be marketed during the Special Review. Under the notice of intent to cancel, the firm or firms possessing the registrations, hereafter known as the registrants, receive a confidential notice of the intended Special Review, and are given

30 days in which to dispute the reason for the Special Review.

If at the conclusion of the response period the EPA decides to continue the Special Review, a notice initiating the Special Review is published in the Federal Register. A document known as the Position Document 1 (PD 1), which discusses the studies which triggered the EPA's actions, is also released at this time. In addition, at this time the public is invited to comment on the Special Review and provide additional relevant information. The EPA may also require the registrant to generate data on the risks of the pesticide at any time.

The next part of the process is the preparation of a comprehensive risk and benefit analysis of each use of the pesticide which is under review. This analysis discusses exposure, risks, benefits, regulatory options, comments received in response to the announcement initiating the Special Review, and the proposed regulatory decision. Included in this framework is a detailed economic analysis of the potential effects of the various regulatory options on the users of the pesticide and the consumers of the treated commodities. The analysis also contains an examination of the potential alternatives to the chemical undergoing Special Review. This risk and benefit assessment is published as the Position Document 2/3 (PD 2/3).

The economic analysis attempts to predict the short-run consequences of the suspension or cancellation. When the analysis is prepared for a suspension, potential consequences for the first year following suspension are examined. This time frame is needs," provided that registration for such uses has not previously been denied or canceled by the EPA. The distribution and application of the pesticide for these uses is confined to the state issuing the special local need permit. A special local need is defined as an existing or imminent pest problem within the state for which an appropriate federally registered product is not sufficiently available. Generally special local need permits are authorized for periods of no more than five years.

### 2. The Selection Procedure

The purpose of this effort is to examine the consequences of the removal of individual pesticides from the market. The pesticides studied were consequently chosen with an eye towards several characteristics.

The first step was to choose a pool from which to draw potential pesticide cases. Pesticides admitted into this group were required to satisfy two criteria. The pesticide must have undergone Special Review with the final result being cancellation of some or all of the registered uses. In addition, the pesticide must have been off the market for at least five years. The fulfillment of these criteria increases the probability of ✓ observing the consequences of the regulatory actions and the responses of the market. The preliminary pool of potential cases consisted of benzene hexachloride (BHC), chlordane/heptachlor, chlorobenzilate, DBCP, ethylene dibromide (EDB), endrin, EPN, 2,4,5-T, sodium cyanide, sodium fluoroacetate, strychnine/Compound 1080, nitrofen, and toxaphene.

The final step of the selection procedure consisted of examining the benefit analyses in the PD 2/3s of all pesticides in the preliminary pool. The intent of this inspection was to identify pesticides whose cancellations were predicted to have relatively severe impacts on well-defined uses or sites. By selecting pesticides with large projected impacts, the study is more likely to observe the realized impacts of the cancellation. Restricting the analysis to well-defined sites facilitates the collection of information on current cultural practices on that particular site.

The pesticides and their sites which were selected are DBCP as a nematicide on California grapes, nitrofen as a post-emergent herbicide on California cole crops (concentrating on broccoli and cauliflower), and 2,4,5-T for use in conifer release in the Northwest and Southeast.

# III. DBCP

The case study of dibromochloropropane (DBCP) and the consequences of its cancellation is limited to the effects on vineyards in California. The EPA initiated a Special Review of DBCP in 1977, and the registrations for all uses, except pineapples in Hawaii[2], were voluntarily canceled by the manufacturers effective in October 1979. However, the state of California suspended all uses of DBCP within the state in 1977.

## 1. History of DBCP Use[3]

DBCP had been used as a post-plant nematicide in California vineyards since its introduction to the market in the mid 1960's. Approximately 31% of California's grape acreage was undergoing a DBCP treatment plan during 1974-1976[4]. This amounted to 165,000 acres and was located almost exclusively in the five counties comprising the San Joaquin Valley.[5] DBCP use was concentrated in this area for two reasons. First, 82% of California grape production is in these five counties. In addition, soils in the San Joaquin Valley are conducive to infestations of the nematodes affecting grapes.[6]

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[2] The registration for use of DBCP on pineapples in Hawaii was later canceled also.

[3] All material in this section is from [11], unless otherwise noted.

[4] This is the estimate from the preliminary benefit analysis prepared by the EPA. Other sources have estimated the use at 10-15% .

[5] These counties are, in order of acres of grapes in 1974, Fresno, Kern, Tulare, San Joaquin, and Madera.

Grapes can be separated into three main types; 1) raisin grapes, 2) wine grapes, and 3) table grapes. DBCP use was unevenly scattered across the grape types. Ninety percent of the California table grape acreage were treated with DBCP, while only 25% of wine and raisin grapes were treated. The disparity is due to two factors. Almost the entire California table grape acreage is grown in the San Joaquin Valley, while a smaller percentage of the raisin and wine grapes are grown in the Valley. The value of the crop probably plays the significant role in determining the use of DBCP. Profit maximizing growers operate so as to set the marginal cost of DBCP applications equal to the expected marginal revenue the application generates. The value of table grapes is consistently at least twice as high as the value of wine and raisin type grapes. Raisin grapes were generally more valuable than wine types, but only slightly.[7] Quite naturally application of DBCP would be more common in vineyards devoted to the higher valued commodity.

Nematode control in vineyards was generally undertaken for the entire lifetime of the vineyard. A nematode management plan commences with the proper cultural practices prior to establishment of the vineyard. It is recommended that planting be preceded by grass crops such as oats and barley since they are poor hosts for root knot nematodes. Vines are generally planted in late winter or early spring. The planting is usually preceded by a fumigation with D-D, 1,3-D, Methyl Bromide, or EDB[8] in late summer or early fall (most commonly in October). The fumigation process requires proper soil preparation, in the form of chiseling, to enhance the penetration of the fumigant. When properly performed, the pre-plant treatment will be effective for two to five years.

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[6] The major nematode affecting grapes is the root knot nematode, however sporadic minor problems occur with the dagger nematode, root lesion nematode, citrus nematode, and pin nematode.

[7] For example, in 1983, the price per ton of table grapes was $647, while the prices per ton of wine and raisin grapes were $208 and $281 respectively.

Upon determination that nematodes were present and affecting plant vigor, the vineyard was treated with DBCP. Application was usually by flood irrigation, however occasional use of chisel injection occurred. Rates of application were approximately 2.86 to 3.57 gallons per acre. The cost of DBCP during 1976 was approximately $11 per gallon. Post-plant treatments were applied at one to three year intervals, depending upon the severity of the infestation and the characteristics of the soil.

### 2. Projected Impact[9]

The preliminary benefit analysis forecast a significant impact on California grape growers, since at the time of the analysis there were no federally registered post-plant nematicides for grapes.

The cancellation of DBCP was not projected to affect the establishment procedures for new vineyards, since DBCP was used solely as a post-plant treatment. Two major crop effects were registered alternatives to DBCP. Shortly after cancellation, two preexisting pesticides were granted special local need permits for use in California vineyards. In 1983 Nemacur (fenamiphos), produced by Mobay, was granted a special local need permit in California for application to grapes. The allowed application methods were broadcasting and banding of the granular formulation, and treatment through drip irrigation lines with the emulsion [4], [8], [9]. Around 1980 FMC obtained a grape registration for broadcast application of Furadan (carbofuran). In 1986 a special local need permit for application of an emulsion through drip irrigation lines was issued [6], [8]. It should be noted that both of these products were on the market prior to DBCP cancellation, they simply did not have registrations to control nematodes in grapes. When asked why registrations were not sought prior to DBCP cancellation, producers agree that their products could not compete with DBCP on a cost-effectiveness basis [6], [9].

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[8] Ethylene Dibromide (EDB) was canceled in September of 1984.

[9] All material in this section is from [11], unless otherwise noted.

It is generally agreed upon,except by Mobay and FMC, that Nemacur is the only effective post-plant treatment for nematodes in California vineyards. Professionals in the field feel that Nemacur is as effective in controlling root knot nematode damage as was DBCP [8]. The only reason that Furadan is applied is that it possesses several desirable insecticidal properties. While Nemacur can be broadcast or banded, the results with these methods of application are inconsistent. Consequently, Nemacur is almost always applied through drip irrigation systems [8]. Approximately 25% of California grape acres are drip irrigated. This is about 15% of wine and raisin acreages and 50% of table grape acreages

[8]. The prevalence of drip irrigation in the industry is increasing due to several factors. Drip or trickle irrigation uses substantially less water than other forms of irrigation. It is estimated that under arid conditions, drip irrigated crops require 25% of the water that flood irrigated crops need [10]. If the trend of forcing growers to bear a larger share of the social cost of providing irrigation water continues, the incentive to use drip irrigation will increase. The final condition contributing to increases in the use of drip irrigation is that it is the only way to effectively control nematode infestations. These incentives have helped to counter the high cost of installing a drip irrigation system. The use of drip irrigation makes available the use of Nemacur as one option in a nematode control program, however it does not guarantee its use.

Nemacur is applied three to five times a year during the times when the root system is most vulnerable to nematode attack. Approximately 1 pound of active ingredient is applied per acre in each treatment [4], [8], [13]. Over the course of a growing season, it is estimated that the average Nemacur treatment program costs about $75 per acre. The returns on control costs vary, as one would expect, by grape type. With table grapes, the rate of return on Nemacur treatments is calculated to vary between $20 and $40 per dollar spent on control. This compares with the estimate of $28 return for each dollar spent on DBCP treatments[10]. The return on wine grape control costs is approximately $3-$9 per dollar spent. Raisins are not generally treated for reasons to be discussed later. It is suggested that a return of $3 per dollar of control costs is required to make Nemacur application profitable [8]. Quite obviously this refers to the average return, not the marginal return.

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[10] It is not clear to this researcher if these figures are comparable. If changes in relative prices of grapes and pesticides were different between the years for which these are calculated, they are not comparable.

There are several adverse consequences of Nemacur use. If the irrigation water containing Nemacur lies on the ground too long, bird kill may result. Another potential drawback occurs when the application rate is too high. When this happens, bacteria in the soil may degrade the compound, thereby reducing its effectiveness. Nemacur, contrary to DBCP, does not actually kill nematodes, it simply repels them. Therefore if the pesticide is metabolized, the control is lost. [8], [13]

An increasingly common response to DBCP cancellation is the use of root knot resistant rootstock in the establishment of new vineyards. Raisin acreages are already predominantly on Thompson Seedless roots, which are resistant to root knot nematodes. One drawback is the cost of grafting which adds $1 per plant. Planting rates are approximately 450 plants per acre, consequently the added cost of grafting is substantial. However when one takes into account that the lifetime of a vineyard is up to 100 years, the nematode resistance can cover the added expense of grafted plants. [3], [8], [15].

As stated previously, not all acres are drip irrigated, and therefore treatable with Nemacur. Several strategies are undertaken on these vineyards. Both Nemacur and Furadan are available in granular formulations. While results are very spotty, some is still applied [8]. The major way to limit nematode damage on these vineyards is to reduce stress on the vines as much as possible. This is accomplished in a number of ways. Instead of irrigating every three weeks, these growers will generally irrigate every two weeks. In addition, the use of certain cover crops may limit the amount of nematode damage to grape roots [3], [8]. Finally, applications of manure to the soil can help limit the effects of nematodes on grape roots [3]. In general, anything which enhances root growth and nutrient uptake will help reduce nematode damage.

One final note is that all of these adjustments in nematode control practices are only effective on the root knot nematode. Nemacur only repels root knot nematodes and all of the resistant rootstock are only resistant to root knot nematodes. Since the root knot nematode is by far the most prevalent and damaging nematode in California vineyards this is a minor point, However, for vineyards infested by other nematode species, there is as yet no solution.

## 4. Conclusions

Some California viticulturists have been able to adjust to the cancellation of DBCP by substituting with Nemacur and Furadan. Other growers have resorted to more intensive cultural practices to lessen nematode damage. These changes have allowed growers to escape the consequences predicted by the PD 2/3. The two major consequences predicted in the benefit analysis were a drop in

## IV. NITROFEN

The case study of nitrofen (also known by the trade name Tok) and the consequences of its cancellation are limited to the effects on weed control in the cole crops of California. In particular, the cole crops to be examined are broccoli and cauliflower. These crops are chosen since consumer demand for them has been rising while demand for other cole crops, such as cabbage have been decreasing in the past decade. By choosing a crop which is experiencing a surge in popularity, it is more likely that the adjustments to the cancellation of nitrofen will be observable. The EPA initiated a Special Review of nitrofen in 1979. The preliminary benefit analyses were conducted in 1980. The registrations for nitrofen were voluntarily canceled in 1983. However, all use of nitrofen in California had ceased by 1979. It is unclear if this was due to the initiation of the Special Review of nitrofen by the EPA or cancellation by California.

### 1. History of Nitrofen Use[11]

Nitrofen use in California was widespread prior to cancellation. Nearly all cole crops were treated on a pre-emergence basis to control broadleaf weeds. In 1977, 66,000 acres of broccoli were treated with nitrofen (93% of total), and 32,500 acres of cauliflower were treated (100% of the crop in California). The geographic distribution of cole crop production in California is split into two areas. The coastal areas of California grow cole crops year round. The interior of California, generally the San Joaquin Valley, grow cole crops strictly as a cool season crop. The preliminary benefit analyses did not distinguish between these two areas when describing the cultural practices in use prior to nitrofen cancellation, though it seems likely that they did differ to some extent.

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[11] All material in this section is from [11] and [12], unless otherwise noted.

Cole crops can be started either by direct seeding of the acres or by transplanting of greenhouse started plants. Transplanted plants have a premium of about 3-5¢ placed on them [8]. Approximately half of the acres are transplanted and half are direct seeded.

Approximately 75% cole crops were treated on a pre-emergent basis with a mixture of nitrofen and Dacthal (DCPA) without incorporation. The application rates were 4 pounds active ingredient of nitrofen and 3-6 pounds active ingredient of Dacthal per acre. Fifteen percent of the treated acreage received a pre-plant incorporation of CDEC[12] and a pre-emergent application of nitrofen. Under this management plan, 4 pounds active ingredient of each compound were applied per acre. The final 10% of the treated acreage received a pre-plant incorporation of Treflan (trifluralin) and a pre-emergent application of nitrofen. Application rates were 0.5 pound active ingredient per acre for Treflan and 4 pounds active ingredient per acre for nitrofen.

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[12] CDEC, also known as sulfallate, whose trade name was Vegadex, was suspended by EPA when the registrant decided not to submit requested data to support its registration.

Nitrofen was also used as a post-emergent herbicide on approximately 50% of the pre-emergent treated acres. Nitrofen was generally applied as a wettable powder with 3-6 pounds of active ingredient applied per acre. It was generally sprayed on the crop using ground equipment one to two weeks after crop emergence, while the weeds were still in the seedling stage. One application per season was generally enough.

Field work was also required to control the weed populations. The preliminary benefit analyses reported that five cultivations per season were undertaken on cole crops in California. However, conversations with Extension personnel and published accounts on cole crop production indicate that mechanical cultivation was usually performed two to three times per season [6], [8], [10], [15]. Crops grown in the winter generally need fewer cultivations than those grown at other times. Cultivation is discontinued when heads on the plants start to form. In addition to the cultivation, one hand hoeing to remove the remnant weeds is usually performed.

### 2. Projected Impacts[13]

The preliminary benefit analysis projected a significant impact on broccoli and cauliflower producers in California. The lack of post-emergent herbicides safe for use on cole crops was the cause.

Three chemical weed management plans were forecast to be used. Dacthal and CDEC were expected to be used as a pre-emergent treatment. The expected application rates were 9 pounds and 4 pounds active ingredients per acre, respectively. This was predicted to be used on about 70% of the acres. On 20% of the impacted acreage the hypothesized response was a post-plant incorporation of Treflan, and a pre-emergent application of Dacthal. Rates of application were expected to be 0.5 and 9 pounds of active ingredients respectively. The final 10% of the acreage was projected to be treated with a post-plant incorporation of Treflan at 0.5 pound of active ingredient per acre. This would the be followed up with a pre-emergent treatment of 4 pounds active ingredient of CDEC per acre. While not explicit in the PD 2/3, further research leads to the conclusion that these treatments were intended to be rotated in order to provide control of the broadest spectrum of weeds [1].

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[13] All material in this section is from [11] and [12] unless otherwise noted.

Field work was also projected to change in order to control those weeds which escaped the pre-emergent treatments. Cultivations were predicted to rise to seven cultivations per growing season, while an additional hand hoeing operation was expected to be needed also.

Even with the additional field work, yields were still projected to fall due to the increased weed populations. Yield losses were estimated to be between 10% and 20% depending on the chemical weed control plan used.

The PD 2/3 also mentioned that the existence of large fixed costs to the production of these crops would cause growers to refrain from switching to other crops. These fixed costs are in the form of special packing equipment required for cole crops.

ammonium nitrate or ammonium thiosulfate (Thiosul), although others such as liquid urea, Entac, and sulfuric acid are used [8]. Fifty to 75 gallons per acre are applied using precise directed sprays. The sprayers are mounted on sleds which allow for precise placement on the weeds, but away from the crop. The sprays are also applied under lower pressure to reduce swirling of the ammonia, thereby further reducing the chance of crop damage. However, what crop damage does occur is generally not serious, and the plants recover nicely due to the increased nitrogen [6], [7], [8].

The spray must be applied early in the season when the weeds are at the 2-true leaf stage. The ammonium will burn the weed sprout thereby killing it at this young stage. A delay of irrigation for 2-3 days is necessary to get maximum burn. Treatment is only performed once in the season. This is because further treatments do not have any appreciable effect. This is probably caused by the weeds hardening off and also becoming more competitive due to the increased nitrogen [6], [7], [8]. This treatment is used extensively on both the coastal areas and in the interior growing regions.[14] However, the results on the coastal areas are more predictable and successful than those in the interior. In the San Joaquin Valley the hotter, more sunny weather leads to thicker cuticle development, thereby leading to reduced weed species which escape control and become persistent problems. With the limited chemical alternatives available there is no herbicide rotation that can keep these weeds at manageable levels. Those species which are hard to control are purple and yellow nutsedge, mustards, russian thistle, cudweed, horseweed, and fleabane [7].

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[14] There is some debate (or confusion) on the effectiveness of the ammonium sprays in the interior growing areas. However Extension personnel in the San Joaquin valley assure this researcher that the sprays are just as effective as they are on the coast when applied properly [6].

### 4. Conclusions

The development of ammonia sprays for post-emergent weed control has been the main adjustment to the cancellation of Nitrofen. While the assumption of constant technology in the PD 2/3 benefit analyses did not allow for predictions of this sort, the projections for pre-emergent weed control techniques were generally accurate.

The preliminary benefit analysis also predicted that some broccoli acreage would shift to other crops. While this has not been observed, another geographic trend has occured. There has been a shift of cole crop production from the coastal areas to the interior growing regions. This has been attributed to the increasing land prices along the coast [6]. The extent to which nitrofen cancellation affected this change in land use is unclear, though changes in the return to cole crop production would certainly have an effect.

# V. 2,4,5-T

2,4,5-T is a post-emergent herbicide formerly used in a wide range of applications to control shrubs and trees. This case study is limited to its use in forestry for conifer release in the southeastern and the northwestern United States. 2,4,5-T has been the subject of intensive regulatory interest since 1970. In 1979 the Administrator of the EPA issued an emergency suspension of 2,4,5-T for use in forestry and a number of other uses. This action bypassed many of the steps of the Special Review process, and went directly to administrative hearings. The end result of the hearings was the cancellation of all uses of 2,4,5-T in 1985.

## 1. History of 2,4,5-T Use[15]

Conifer release is a silvicultural practice designed to reduce the effects of brush and other vegetation on conifer growth and survival. These adverse effects take the form of reduced moisture and sunlight for the crop trees. Release is used after the establishment of the conifer stand, generally prior to 8 years of age. Release is a selective procedure which requires a removal or reduction in the vigor of the competing species without causing undue damage to the trees of interest. 2,4,5-T was popular in this application for three reasons. It was not phytotoxic to conifers when applied properly, was effective on a broad spectrum of noxious species, and was a low cost method of release.

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[15] All material in this section is from [14], unless otherwise noted.

2,4,5-T was generally applied in combination with 2,4-D, another phenoxy herbicide, in the Northwest. In the South, 2,4,5-T was generally applied alone since 2,4-D is toxic to southern pine species. The preferred method of application was aerial spraying by helicopter. Fixed wing aircraft were generally not used due to the inability to precisely control the size of the area treated. It has been estimated that 2,4,5-T was applied to 439,250 acres in the South, and 246,000 in the Northwest in 1977[16]. This was 90% of the 2,4,5-T applied in the U.S. Approximately 94% of the 2,4,5-T applied in the South and in the Northwest was applied aerially. Other methods used were foliage applications using ground equipment and manual application, generally by application of 2,4,5-T to cuts in the bark. These figures include not only applications for release but applications for timber stand improvement and pre-commercial thinning. Timber stand improvement and pre-commercial thinning are the selective removal of low-valued or poorly formed conifer trees. Obviously any applications by air were intended for release, not stand improvement or pre-commercial thinning, since these are more selective procedures.

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[16] The national figures indicate that approximately 19% of release, pre-commercial thinning, and timber stand improvement work was accomplished using 2,4,5-T. I suspect that this figure was substantially higher in both the Northwest and the South due to the larger more inaccessible tracts of land. But no evidence can be found to this effect.

applicable to both areas.

One possible remedy to the loss of 2,4,5-T is more aggressive harvesting, site preparation, and regeneration. Prescribed burning prior to harvesting is one phase of this alternative. In areas where this is feasible, this can lessen the need for release by destroying much of the understory and buried seeds. This thereby removes a large source of seed stock from which future competitors will grow. After harvest, intensive mechanical site preparation is then used to assure the most favorable growing conditions for the conifers, and the least favorable for other species. Selection of the planting stock or seeds must then be carefully considered in order to plant the most competitive commercial species in the area. With prudent nursery and planting procedures, most stands should grow vigorously after planting and maintain their dominance over less desirable species throughout the growing cycle.

Mechanical methods of release were projected to be of some value in certain areas. In general this will be limited by the terrain the stand is situated on and the characteristics of the stand itself. Mechanical release equipment is of limited manueverability, so the stand must be fairly open. In addition the stability of the equipment is limited by the slope of the land. These were projected to be of more value in the South, where the terrain is less steep.

Manual release is another option open to the forester. Chainsaws may be used to remove the brush from around the crop trees. There are several drawbacks to manual cutting. The major problem is that resprouting may occur, thereby nullifying the release, though not all species will resprout. Another problem is that the crop trees may be injured either by falling brush or by the chainsaw. There is also the danger of operator injury when using the power tools. An alternative involves the uprooting of the vegetation by hand. This reduces the risk of worker and crop tree injury, and also eliminates resprouting. The drawback to this method is that it requires light textured soils to enable easy uprooting.

Several herbicides were identified for use in release work. These herbicides would either be applied by air or applied to individual problem trees. Those which were considered selective enough to be applied by air are 2,4-D, glyphosate (Roundup), fosamine (Krenite), and amitrole-T (Amino Triazole and Cytrol). However these were only considered for western species, since they are phytotoxic to southern pine species. Triclopyr (Garlon) was also considered as an alternative for release in Douglas fir stands. In the South the only suitable chemical for aerial application was hexazinone (Velpar), though it is not effective on oaks. The other method of chemical eradication is through hack and squirt methods. These simply involve cutting into the cambium of the problem tree and squirting the cut with herbicide. Any of the previously mentioned pesticides is effective when used in this manner. In addition picloram (Tordon), dicamba (Banvel), or bromacil (Krovar and Hyvar) can be applied by this method. As with manual cutting release, manual chemical release is very labor intensive and is not economically feasible when the problem species occur in high densities.

No attempt was made to assign particular alternative methods to specific areas. 2,4,5-T was so inexpensive and effective that it was the method of choice in the South and Northwest, regardless of the specific site characteristics. With suspension of 2,4,5-T, the decision of the method to use for release was projected to become more complex. Individual sites must be examined and the least cost method of release will then be chosen.

As mentioned earlier, the exact effects of failure to perform release is not known with certainty, however estimates were still produced. In the Northwest it was estimated that use of the alternatives would produce the same results as the application of 2,4,5-T, but at a higher cost. Failure to control the growth of undesirable species would lead to a 59% reduction in harvestable wood . Others predicted that there would even be losses under the alternative release methods. In the South no effects were predicted for the use of the alternative release strategies, however failure to perform release was predicted to lead to losses of 14% - 43% at harvest. It should be reiterated that these are strictly guesses and are not backed by solid empirical evidence.

### 3. Current Cultural Practices

The primary change in vegetation management programs since the suspension of 2,4,5-T has been the loss of an universally inexpensive release method and substitution with a collection of release methods tailored to specific sites. The response of forest managers to the loss of 2,4,5-T has varied between regions.

In the Northwest the trend has been towards more aggressive site preparation to lessen the need for release activities. This has been evidenced by the increased popularity of prescribed burning. The use of burning is advantageous due to the large amount of slash and heavy underbrush present. One problem encountered with prescribed burning in the Northwest is that the burning must be properly managed to control the smoke produced and preserve air quality. [11], [13], [16].

Site preparation in the South has also changed since the cancellation of 2,4,5-T. After the cancellation, site preparation became an important component of vegetation management in the South due to the limited alternatives for release. However since the introduction of a new herbicide called imazapyr (Arsenal) intensive site preparation has decreased. The timber industry has found that it is less costly to substitute release activity with imazapyr for intensive site preparation. The limited site preparation consists of chopping with disks or drums pulled by heavy equipment. The area is then burned and the seedlings are planted. Chemical release activities are then performed in 2-3 years. [6], [19].

Very little mechanized release activity occurs in either the Northwest or in the South. The main reason for this is the lack of any equipment which is able to effectively remove the offending brush without damaging the crop trees. [6], [11], [13].

Manual release is used on all U.S. Forest Service land requiring release in the Northwest. This is because since 1983 the Forest Service's Region 6, comprised of Washington and Oregon, has been under a court order barring application of herbicides. The injunction is effective until the Forest Service collects additional information on the worst case scenario of herbicide use for its environmental impact statement. This is expected to be accomplished by the end of 1988 [13]. The major problem growths on this land are red alder and salmonberry. By cutting the alder at an age of 6 years between June 1 and August 1, the Forest Service has found that they are able to effectively control resprouting. This will give the crop trees the needed time to grow. Additional research is in progress to find a similar window of opportunity with salmonberry [13]. Approximately 25% of the commercial timberland in Region 6 will receive this treatment during the growing cycle. Manual cutting is only used on the private industrial forests of the Northwest when release is needed near streambanks [11], [17].

In the South, manual release by cutting is seldom used. While the equipment necessary to perform these activities exists, the labor force willing to perform the activities does not. This type of work is physically exhausting, at wage rates which make it a feasible release strategy, laborers are reluctant to accept the work [6], [19].

Almost all release in the South is performed using herbicides. The herbicides commonly used are glyphosate, hexazinone, triclopyr, and a new entrant produced by American Cyanamid, imazapyr (Arsenal). Triclopyr is applied strictly as a basal spray to individual problem stems, while the others can either be applied as a basal spray or as a foliar spray.The most popular is a combination of glyphosate and imazapyr. Imazapyr has only been available for use in forestry for about one year, but it seems to be a hit with foresters. [6], [19]. Aerial application is by far the most common method of application in the South. However in the last three years increasing attention has been paid to ground application by either motorized vehicles or by backpack sprayers. It is generally considered economical to perform release from the ground if problem stem density is less than 600-700 per acre. Any density greater than this and aerial application becomes more cost-effective. One possible explanation for the increase in ground application is the sharp increase in insurance costs of aerial spraying. In fact some aerial applicators have had difficulty obtaining insurance in amounts greater than $300,000. However, this connection is unclear. [6], [19].

In the Northwest the most commonly used release chemicals are 2,4-D, glyphosate, and triclopyr (ester formulation). Occasional use of atrazine, dalapon, and simazine is made. Application methods are approximately split between aerial and ground applications. Imazapyr is not used on northern conifer species since it is phytotoxic to the species grown. [8], [11], [17].

One final development in silviculture has helped to lessen the need for release. The vigor of the seedlings being planted has improved tremendously over the past 10 years. These seedlings are able to begin growing immediately after planting. With proper site preparation, the seedlings are able to get the jump on brush and hardwood growth. [13].

## 4. Conclusions

It is generally agreed upon by knowledgeable foresters that the herbicides which replaced 2,4,5-T are more effective than the herbicide they replaced, however the alternatives are more expensive than 2,4,5-T.

The low cost of 2,4,5-T led to widespread use of release. Foresters substituted release work for more expensive site preparation. The low cost led to indiscriminate use. It was less costly to treat large areas than inventory the stands and determine the need for release. With the loss of 2,4,5-T, foresters were left to use chemicals which are more expensive. This forced careful consideration of stands to determine the least cost method of obtaining vigorous conifer growth. In some areas this may involve aggressive site preparation, while in others it may require intensive release activities. The wide range of growing conditions in both the Northwest and the South leads to large variance in the vegetation management decisions. [6], [11], [17], [19].

## VI. RECOMMENDATION

In each of the cases studied, new pest management practices have evolved to replace those lost. Nemacur has been registered for use as a nematicide in vineyards, thereby reducing the consequences of DBCP cancellation. The development of ammonia sprays to replace nitrofen has had the same effect in cole crops. Other developments in forestry have lessened the impact of the cancellation of 2,4,5-T. These advances have diminished the effects of the registration cancellations. While the assumption of constant technology used in the benefit analyses is the only feasible method to predict the consequences of cancellation, the expected impact of cancellation is of interest to regulators. Knowledge of elements which affect the incentives and capacity for innovation in a market will assist the EPA to judge the expected consequences of regulatory actions.

Developments in pest management arise in two different sectors. The private sector, consisting mainly of chemical firms and farm equipment manufacturers, innovates in order to earn profits. The public sector, composed of non-profit agricultural research organizations, responds to the perception of a need for improved pest management practices. Research activity in these sectors will vary depending upon the characteristics of the particular market being served. Factors affecting the research activity of these sectors will be examined in this part.

The incentive for research in the private sector is profit. Firms will attempt to develop a product when the expected revenue exceeds the expected cost of development and production, in other words, when expected profits of the project are positive. The maximum profit available to the firm is limited by the size of the total surplus or total private benefit of the product[19]. The profit actually received by the firm is a function of the price elasticity of demand for the firm's product. Since the demand for the pest management input is a derived demand, its characteristics will depend heavily on the nature of the demand for the output of the growers. It will also depend upon the marginal productivity of the pest control method. While little can be said about the productivity of a pest control method in advance of its development, the demand for the crop can be readily characterized.

Crops which comprise a sizable share of the dollar value of agricultural output will attract innovative activity. These are crops for which either there are a large number of potential purchasers or which have a high value per unit of output. Crops with large markets will mean a large market for pest control methods. In this case the fixed costs of product development can be spread out among the many growers, thereby reducing the break-even price of the product. For crops with a high market value, pest control will play a large role in the cultural practices. This is because even minor yield losses will lead to large revenue losses for the grower. New pest control methods for these crops need not be very productive to offer a profitable return to the developing firm since the marginal revenue product of the pest control product, and hence the value to the grower, is so high. For these reasons, markets with relatively large total private benefits will recover more readily from regulatory actions since there is a potentially large payoff for the innovative firm.

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[19] technically this is the integral over own price of the market demand function of the product in the positive orthant. .

The growth in demand for the crop will also affect innovation. Firms' decisions are made with a long time horizon. If the market is currently small, but undergoing significant growth, the incentives to serve the input market are increased since the future market size will be greater. In the same way, large but shrinking markets will tend to have a low level of innovative activity since the future payoffs to innovation are falling.

The price elasticity of demand[20] for pest control inputs will also affect the incentives to undertake research on new pest management methods. The more inelastic the demand, the more surplus the innovative firm can appropriate. The major variable affecting the elasticity of an input is the availability of substitutes for the input. Few substitutes for a particular pest control strategy leads to inelastic input demand, and consequently strong incentives to develop substitutes for canceled pest control products. The elasticity of demand for the crop also affects the elasticity of input demand since input demand is a derived demand. A highly inelastic demand for a crop leads to a highly inelastic demand for inputs since the grower can easily pass on higher production costs to consumers.

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[20] The price elasticity of demand measures the responsiveness of the quantity demanded to changes in price. An inelastic demand function indicates that changes in own price have little effect on the quantity demanded.

Care must be taken in defining the appropriate market for pest control products. FIFRA has created artificial sub-markets for pesticides by requiring that pesticides obtain a separate registration for each crop it will be used on. It is then illegal for a grower to use the pesticide on crops for which it is not registered. In this way the market definition from the firm's standpoint may be quite large since it chooses which crops to register the pesticide for. However from the standpoint of the grower, the market may be quite limited since effective pest control chemicals may exist but be unregistered for his crop[21]. In this way the innovating firm has a broad range of markets to support its primary development expenses, yet the grower may have a limited number of substitutes.

These artificial sub-markets also create the opportunity for price discrimination by pesticide producers, which will lead to higher profits and greater incentives to innovate. By slightly changing the formulation of a pesticide, the firm can create separate products in the eyes of FIFRA. The firm can then target the different formulations at different crops, thereby creating small separate sub-markets for each formulation. The profit-maximizing price is then charged in each sub-market rather than pooling the markets and charging one price. The profits under this discriminatory pricing scheme will always be greater than those under the pooling outcome when the costs of registering additional formulations are minimal. In this way FIFRA may actually increase the incentives to innovate when there are many potential uses for a pesticide.

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[21] This was the case with Nemacur and vineyards prior to 1980.

The public sector responds differently than the private sector, yet many of the same elements affect both sectors. The perception of a need for improved pest management techniques spurs innovation in the public sector. Many times the same elements which signal an opportunity to firms will attract the attention of these organizations.

The key factor which affects the public sector is relatively unimportant in the private sector. This factor is the existence of a well-defined constituency that will benefit from the innovative activity. Availability of the resources needed to innovate will be enhanced by the existence of this constituency. Since there are many competing uses of public funds, the absence of this group will lead to resources being allocated to other uses. These constituencies exist for many crops and have generally been able to advance the creation of support networks such as the Agricultural Extension Service. The existence of this support network is a prerequisite for innovative activity in the public sector.

When an entire constituency is adversely impacted by regulation, there is little doubt that the support network will respond. However, if only a fraction of the constituency is affected, the public sector may not respond. The affected constituency must be able to organize and indicate to the public sector that they are deserving of assistance. Concentration of the affected constituency facilitates this. If the affected parties are widely dispersed they may be constituents of different support networks and therefore unable to assist each other in exerting influence on the allocation of research effort in the public sector.

The ability to estimate the innovative potential of a particular market will allow regulators to judge the duration and severity of the predicted consequences of regulatory actions. A large share of the information needed to accomplish this analysis is already incorporated into the benefit analyses. By organizing this information to indicate the innovative potential of a market, the EPA may be more able to accurately judge the long-term consequences of pesticide regulations.

# VII. CONCLUSION

In all of the cases studied we have seen the introduction of new pest management products and techniques. These have ranged from the introduction of already existing products into new markets to the development of entirely new methods of pest control. Unfortunately since this research has been limited to examining current cultural practices, many facets of the adjustment process have been ignored.

Some areas have been left out due to the lack of adequate information. The history of pest management of a crop between the time of cancellation and the present is difficult to obtain as these are generally poorly documented and the memories of individuals have faded. However a careful search of the literature could provide enough documentation to reconstruct the events following cancellation of a registration. A study of this sort would certainly provide valuable insights into the dynamics of the adjustment process.

The benefit analyses generally project the effects of the regulatory actions on the market for the crop. This study has not examined the consequences of cancellation on prices and output of the affected crops. The main reason for this is the complexity of the market mechanism. The number of constantly changing variables affecting the market for the growers' output is immense. Attempts to model this process have been characterized by low explanatory power. Very little information on the consequences of cancellation would be obtained from a study of this type.

It is hoped that this paper will alert pesticide regulators to the short-term nature of the adverse consequences of regulatory actions and stimulate further interest in predicting the propensity for innovation in affected markets.

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Although, the assessment report fails to quantify NPS impacts by stream miles or lake acres, fishing and swimming use reductions have been field-verified by staff in 135 waterbodies.

Much of the assessment report reprints a series of maps distinguishing watersheds by the type of impact shown by at least one associated waterbody. The maps do not address the extent or severity of impacts within the watershed.

The 305(b) report notes that funding for the state's Clean Water Incentives Program, which addresses NPS pollution, is inadequate.

1. Standards:

Michigan has not applied its water quality standards to a NPS analysis. The Sec. 319 report reflects only the judgments of survey respondents and is thus considered to be an impact indicator. Reliable measurements of impacts will be conducted over the next two years.

2. Sources of impact information:

The MDNR sent out survey forms to 128 agencies representing federal, state and local interests. They range from county drain commissions to state agriculture offices and national parks. In addition, MDNR staff field surveyed some waterbodies to verify reported impacts.

3. Waterbodies covered:

The 319 report discusses impacts to lakes and streams. No data are presented for groundwater or wetlands. Great Lakes impacts are discussed in a general way without specific data. Many of the NPS impacted waterbodies listed in the report are Great Lakes shorelines and tributaries.

4. Impact source categories:

While the USEPA source categories are listed in the 319 report, waterbodies are not described by the sources which affect them. Still, the state is described by the percent of watersheds affected by each source. The reports do not say whether or not Michigan accepts each USEPA category as a nonpoint source or regulates some as a point source.

5. Impact parameters:

The 319 report lists 11 effects of NPS pollution and describes the state by the percent of watersheds reflecting each one.

6. BMP selection process:

The 319 report discusses Michigan's Nonpoint Source Management Strategy which identifies programs and procedures for controlling NPS pollution. Specific practices and procedures are not discussed.

7. Other programs:

The assessment report lists a variety of local, state and federal programs ranging from the Rural Clean Water effort to stormwater management programs. Three of the listing categories are coded, but no key is provided.

8. Public review and comment:
None was conducted.

9. Milestones:
In 1989, the MDNR intends to analyze specific watersheds for the problems identified in the assessment. The staff will prioritize watersheds and use models to design solutions.

10. Extent of NPS pollution:
NPS pollution has widespread impacts on Michigan waters, but the exact nature and extent of these problems are not well understood. Out of 297 watersheds included in the 319 report, 296 have reported NPS problems. Within those areas, 608 rivers, creeks and drains have reported impacts. A total of 827 lakes, ponds and impoundments are similarly listed. Sources affecting the most watersheds include septic tanks (81%), streambank erosion (80%), agricultural erosion (75%) and construction site erosion (74%).

Altogether, designated uses are not being met in 135 bodies of water. Most of the use violations have been verified by staff, although little monitoring has been performed to support these judgments.

The reported impacts are not related to the extent of problems within each watershed or the severity of a particular problem.

11. Issues:
Michigan is just beginning to meet the requirements of Sec. 319. Problems with the 1988 effort reflect the complexity and scope of nonpoint pollution and the amount of money budgeted for the assessment. In order to complete the reporting requirement, the MDNR must:

. Identify specific lakes, river reaches and wetlands by NPS impact and source.

. Identify the basis for impact determinations and use reductions. Their relation to state water quality standards should also be noted.

. Describe the processes used for selecting BMPs.

. Identify state and local programs that address NPS pollution.

. Submit the report for public review and comment.

## Michigan Management Plan

The Michigan Dept. of Natural Resources' draft NPS Management Report describes broad objectives and policies for controlling nonpoint pollution sources. Michigan will use a two-tier prioritized approach composed of a state-level watershed effort and existing agency programs. The report specifies two basic program types (preventive and corrective), major administrative elements and the need for ongoing documentation. Also identified are proposed and existing corrective programs by source categories and the agencies which conduct them.

The MDNR Surface Water Quality Division is listed as the lead agency in the state level program. Among its duties are coordination, continuing development of assessment and management reports, federal fund administration and enforcement.

Participating in planning and implementation are a variety of state and federal agencies with specific statutory responsibilities.

The report notes (p. 155) that future program priorities will depend heavily on funding levels. For example, low level Sec. 319 funds might be focused on statewide education and assistance, whereas larger amounts might be applied to watershed projects and monitoring. The potential for new state funding is not discussed, but the report points out that existing programs already reduce nonpoint problems. Nevertheless, existing programs listed in the report are characterized as inadequately supported.

As presently written, the report is inadequate in several fundamental respects. First, the role for the statewide nonpoint source assessment is not clearly described. The Executive Summary notes that since funds are limited, programs will have to be prioritized. Toward that end, among others, the Clean Water Incentives Program (CWIP) has been established. While the assessment could rank impacted waterbodies for use in the CWIP (in present form, it does not do so), its role in program or project selection is discussed only by a passing reference.

On page 151, the assessment is included as one of the driving forces of watershed planning. To fulfill that role, the assessment will have to incorporate adequate monitoring and a standards based ranking mechanism. Otherwise it will serve only as a data base.

A second major gap lies in the absence of a monitoring and evaluation component of the overall NPS strategy. Proposed programs, such as the Multi-Agency BMP Implementation and Evaluation Program and the watershed demonstration projects, contain monitoring elements, but evaluation is a fundamental part of management at all levels. Among the stated objectives is the need to "improve overall documentation" of the pollution control work. That implies an ongoing monitoring and evaluation effort.

Additional gaps include the following:

. Groundwater impacts of BMPs.

. Function of the CWIP in establishing a screening process, funding sources and evaluation procedure for watershed projects.

. Identification of federal programs for consistency with the state NPS program.

. Identification of existing programs by source category.

. Identification of funding sources other than Sec. 319 (h) and (i), which make up a large portion of funds currently listed. Funds from those two subsections are specifically excluded by the Act. Local, state and federal agency funds need to be considered.

. Coordination of the CWIP and existing programs with the assessment report and the state Water Quality Management Plan.

. Identification of the preventive programs mentioned in the executive summary.

The draft report notes that the final report will include some of these items.

1. BMPs identified:

The MDNR's nine technical committees are presently assembling lists of BMPs and their groundwater impacts. Still, the draft report lists 127 BMPs in a matrix that identifies the nonpoint sources they may be effective in controlling.

2. Programs identified:

The report lists both existing and proposed corrective programs by seven source categories: agriculture, urban, transportation, forestry, construction sites, septic systems, and general. Many sources are not addressed. They include landfills, sludge spreading, channelization, fuel tank leaks, in-place contaminants, atmospheric deposition and boating.

Still, by describing proposed programs in detail, the report gives a clear direction for future NPS control programs.

**Proposed agricultural programs** focus on soil erosion, animal wastes, groundwater impacts, pesticides and fertilizers. These efforts constitute the largest single area of potential NPS programs. Existing programs use a well-developed framework of local agencies, and the new efforts would fit within it. Among the proposal types are incentives, modeling, training, research, surveys, and regulation.

**Urban programs** focus on stormwater, data systems, pesticides, groundwater impacts and wetlands use. The report notes the Clean Water Act's stormwater provisions and calls for state-level coordination of an urban program. Michigan has no existing corrective programs in this area.

**In the transportation category**, four proposed programs focus on soil erosion, education and training, highway runoff and research. At different levels, each would attempt to reduce water quality impacts from highway related activities. Current efforts include education and regulations on erosion and research on highway runoff impacts.

**Only one forestry management** initiative is proposed, and no current efforts are identified. The new proposal focuses on training activities.

**For construction sites**, current educational, technical and regulatory programs are in place but inadequately supported. The state's Erosion and Sedimentation Control Act is discussed, but the report does not indicate how well it is enforced. The MDNR has the responsibility for reviewing enforcement agencies to verify compliance with the law. New programs are proposed for training and enforcement.

No current programs are identified for **septic systems**. One proposal is listed, but information will be included in future drafts. (This contrasts with the assessment report's finding that septic tanks problems occur in 81% of Michigan's watersheds.

Under the **general sources** category, the report lists seven new programs: the CWIP, the groundwater protection program, a data management effort, expanded monitoring of NPS impacts, research on NPS related water quality standards, streambank erosion controls and a hydrologic analysis program.

3. Groundwater impacts of BMPs:
To be included in future drafts.

4. Funding sources:
Sec. 319 (h) and (i) funds form the bulk of identified funding. State and local sources are to be included in future drafts.

5. Federal program review:
None is included.

6. Milestones:
None is included.

7. AG certification:
Draft has been submitted to the Attorney General for review.

8. Watershed demonstration projects:
Projects will be selected and implemented through the CWIP. Selection criteria are based on water quality standards violations and non-support of designated uses. The four program phases include detailed assesment, plan development, implementation of NPS controls and evaluation.

Future project needs (p. 166) include consideration of groundwater impacts, funding for the CWIP, research on the safe disposal of pesticide containers and evaluation of the sale and use of pesticides in urban areas.

The use of the MDNR's nonpoint assessment report is not clearly defined in the project selection process.

9. Region V requests:
The report describes the phosphorus reduction program begun in response to the Great Lakes Water Water Quality Agreement. Other requests are not addressed. These include programs to reduce other NPS impacts to the Great Lakes, integration of the NPS strategy with the state Water Quality Management Strategy, programs dealing with in-place pollutants and atmospheric deposition and a description of any memoranda of understanding among participating

agencies.

10. Compliance with 319:

While the report outlines the overall strategy and many potential programs in a future NPS effort, it falls far short of meeting the requirements of Sec. 319. However, the present draft will undergo significant revision before it is submitted Oct. 28. Thus, the MDNR's compliance cannot be conclusively stated at this time.

The agency has made obvious strides in describing a comprehensive new programming effort. The report focuses on new initiatives in seven major source categories and describes the policy framework for the watershed demonstration program. Advisory committees have been established, and watershed projects already begun under the CWIP have been detailed. Current programs at the federal, state, regional, and local levels are also described in detail, although they are not listed by source categories.

Future drafts will address gaps in the current report. These include:

. The groundwater impacts of BMPs;
. Federal programs to be reviewed for consistency;
. Funding sources;
. Attorney General certification;
. A four-year timetable for watershed project implementation.
. Description of a state level tier incorporating NPS assessment and management into the overall water quality management plan.

Also missing from the present document are efforts to address a variety of significant source categories, including those identified in the "programs identified" section of this review. The statewide assessment does not address these sources either, but to be comprehensive, the management program needs to recognize them.

The report appears to be well on its way to complying with Sec. 319.

## Minnesota

### Summary

The Minnesota Pollution Control Agency (MPCA) has met its Sec. 319 requirements in both the 305(b) report and a separate assessment document. While the latter partially repeats information presented in 305(b), it expands considerably on stream assessments and programming.

In 305(b), NPS impacts and programs are discussed separately in two sections, but they play a part in other chapters such as those on water quality trends, causes of non-support, lake information and groundwater quality. In several places, the relative contributions of point and nonpoint sources are stated generally. In contrast, the assessment report explicitly eliminates waterbodies affected solely by point sources.

Using existing STORET data and a survey of resource managers, the reports detail lake and stream NPS problems in every county. The MPCA includes more NPS data on wetlands and groundwater aquifers than any other Region V state agency, and as a result, the reports yield a picture of impacts to every type of waterbody.

Monitored data varies for streams and lakes. For the former, the MPCA reviewed station records for total phosphorus, nitrate-nitrite, total suspended solids and 5-day BOD. Fecal coliform was considered but not included for unspecified reasons.

Lakes were analyzed for Secchi disc and chlorophyl-a measurements and epilimnetic total phosphorus. A Carlson trophic index number was computed for each lake and correlated with swimming and aesthetic conditions. Each waterbody is listed by its status as threatened or impacted, its size, the information source, the effects of NPS pollutants, their source, the waterbody's actual and potential uses and its location.

Evaluated data consist of survey information contributed by local agency staff. In addition, records on citizen complaints were used to supplement the survey responses.

The lack of a quantitative summary precludes a description of statewide nonpoint sources and impacts by stream miles and lake acres. The reports note that the large size of Minnesota's water resource makes a comprehensive assessment too expensive. Nevertheless, results of the survey indicate impacts to about 4,100 waterbodies statewide. In addition, both the tables and discussions point to the pervasive impact of agricultural activities. They clearly account for the lion's share of degraded lakes, wetlands and stream miles. Urban activities and waste disposal (septic tanks, land disposal) account for most other affected waters.

Drawing on groundwater data collected since 1978, the MPCA has included statistical descriptions of chloride and nitrate concentrations in three agricultural zones: intensely, moderately and lightly cultivated. Predictably, the most intensely used agricultural areas also have the highest concentrations of both contaminants.

Pesticide problems are addressed in the description of surveys by the state agriculture and health departments. Although most detections are below remedial action limits, one chemical, Atrazine, was found in nearly a third of all sampled wells. Accordingly, the MPCA suggests that normal pesticide use may pose a threat to groundwater quality in some areas.

Groundwater impacts are listed for 51 counties. Agricultural and waste disposal practices account for almost all of the contamination. Urban runoff and mining activities pollute aquifers in two counties. The 305(b) report describes the MPCA's three-county nonpoint groundwater monitoring project. Assessments are also being performed on the practice of combining agricultural chemicals with irrigation activities.

By not ranking statewide NPS impacts or severely affected waterbodies, the report falls short of providing the basis for a state level, comprehensive management program. However, enough waterbody specific details are provided to assist local improvement efforts.

The reports evaluate waterbodies on an ecoregion basis. For lakes, use support levels are described on the basis of swimming and fishing potential within each region. NPS impacts are listed as a major cause of lake and stream degradation.

Since monitoring efforts target areas of suspected pollution, the report notes that quantitative assessments do not reflect true statewide conditions. Only 4,443 miles (just under five percent) of Minnesota's 91,944 stream miles are listed as monitored in 305(b), and the assessment report lists only 1,588 miles as analyzed solely for nonpoint impacts. Of that total, 1,576 miles showed partial or full use reduction from nonpoint sources.

For lakes, 42 percent of all lake acres are listed as assessed. The results are described by the number of impacted lakes in each ecoregion.

The data are framed in a WBS compatible format. The MPCA coordinates and evaluates NPS control efforts which are implemented by a variety of state and local agencies. The nature of landowner involvement is not stated.

1. NPS Standards:

The report lists actual and potential uses for each waterbody. These qualities are not treated in a ranked order.

The use categories do not appear to work well for wetlands or aquifers. Both are often given unspecified uses, although some are classified for fishing or swimming qualities. Use or impact standards for both waterbodies may need clarification.

For streams an impact determination was reached if ten percent or more of the sample data exceeded the 75th percentile concentration in a given year. Lake impacts were determined from trophic values and a percentage of the time swimming uses were met.

2. Sources of impact information:

The MPCA used existing monitoring station data, survey forms and citizen complaints. Station data were re-evaluated for NPS parameters. Surveyed data are summarized separately.

3. Waterbodies covered:

Specific NPS impacts to lakes, streams, wetlands and aquifers are included on an ecoregion and a county basis. Nevertheless, the assessment notes that a comprehensive analysis for all waterbodies is beyond the scope of current agency operations. Altogether, the assessment covers 12% of all lakes and 5% of all stream miles. No goals are presented for future assessments.

Lake Superior is discussed in a separate part of the 305(b) report. It is not evaluated for NPS impacts alone.

4. Source categories:

The assessment table uses 33 pollution sources grouped in nine categories for all waterbodies. All USEPA categories are represented in the two reports.

5. Impact categories:

The reports recognize nine kinds of NPS impacts for all waterbodies. These range from oxygen depletion to sedimentation, toxics contamination and habitat alteration. Since both impacts and sources are listed in the same table, associations among them are clear and provide a basis for management strategies. The state's standard and control strategy for acid rain is also discussed. A total of 1,075 Minnesota lakes have been assessed for acid sensitivity.

6. BMP selection process:

The report outlines the decision-making framework and the strategies used for selecting particular practices. The Clean Water Partnership (CWP) Program forms the basis for local government implementation efforts under MPCA guidance.

7. Other programs:

The report describes the MPCA's inter-agency coordination efforts as well as a variety of local, state and federal programs aimed at particular sources. The resulting two-tiered approach uses the CWP and the federally funded Clean Lakes programs at the state level and existing agency implementation programs at the local level.

8. Public review and comment:

No public review period is identified. No comments from other agency staffs are included.

9. Issues:

A watershed or ecoregion based priority system for targeting future program funds would facilitate preparation of the management plan. Such a system could rank waterbodies on the basis of designated use support level. However, the report demonstrates the difficulty of using such a system to rank aquifers or wetlands.

Since Minnesota has so many streams and lakes, monitoring for a comprehensive survey would be very expensive. Present data collection efforts seem inadequate for an accurate assessment, and the report notes that the numbers will change as future monitoring is done.

Although the August 4 draft is labeled as the "Public Review Draft," no comment period or public participation strategy is listed.

10. Milestones:

The report does not list a timetable for future NPS assessment efforts.

11. The extent of NPS pollution:

The lack of a summary precludes description of the full extent of NPS pollution by source or pollutant for all waterbodies. Nevertheless, as noted above, farming activities appear to be the most pervasive source in all regions.

For assessed waterbodies, NPS pollution appears to be the dominant cause of non-supported uses. For rivers, 92 percent of non-supported river miles suffer from NPS or unknown impacts. For non-supported lakes, 83 percent receive unknown or NPS impacts.

A regional breakdown of the NPS impacts extent to lakes appears in the 305(b) report as follows (p. 37 and 38):

. The Northern Lakes and Forests region shows NPS impact to less than ten percent of its lakes. Full or partial support of swimming uses seems reasonable.

. The North Central Hardwood Forests shows NPS impairment to about 40 percent of its lakes. Full or partial support seems reasonable, but shallow lakes surrounded by cultivated land may be threatened.

. The Western Corn Belt Plains shows NPS impairment to 89 percent of its lakes. High soil fertility, shallow lake depths, and the high degree of agricultural use make full support unlikely.

. The Northern Glaciated Plains, an area of very shallow lakes, shows NPS impairment to nearly all lakes. Full support is unlikely.

. Other regions are not summarized.

On a statewide basis from all sources, nutrients, fecal coliform, physical parameters, and low dissolved oxygen are the most common causes of impairment to swimming use.

For the 1,408 lakes included in the report (p. 15), 1,005 have full support while 141 have partial. A total of 258 lakes do not support their designated uses.

For 1,588.8 NPS-assessed stream miles, only 12.9 have no impact from nonpoint sources. Most of the rest are fully impacted, a category in which samples violate attainable water quality parameters more than 25% of the time.

Lake Superior is classified as fully supporting all swimming uses. The health advisory for lake trout over 30" long has lead to a designation of nonsupport for fishing uses. Both the MPCA and the Wisconsin Dept. of Natural Resources have recorded excessive PCB concentrations in such fish. St. Louis Bay has been targeted because of PCBs, dioxins and mercury in sediments.

Sediment samples have also been studied in the Rainy River system, parts of which show contamination by dioxins.

## Minnesota Management Plan

Minnesota's NPS management report describes a comprehensive two-tier framework for managing nonpoint pollution problems. The state-level effort is comprised of the Clean Water Partnership (CWP) and Clean Lakes programs. A variety of local, state and federal programs makes up the second programming level.

The report addresses watershed projects by referring to the goals and timetable of the CWP program. Local government units can apply for CWP funds through November, 1988, and ten to 12 projects are due to be awarded in the spring of 1989. A total of $1.3 million has been made available by the state on a 50% matching grant basis. The report does not discuss specific projects or funding sources other than state and local.

Since CWP project proposals are locally driven, it is not clear how the state's nonpoint assessment report will be used as a management tool. The impacted lakes, streams and wetlands identified by the assessment constitute an extensive data base that could be used in project selection or evaluation, but the assessment's role is simply not mentioned.

The management report fails to meet Sec. 319 requirements in several other areas:

. Demonstration projects associated with public water supply reservoirs, lakes or wellheads are not discussed.

. The groundwater impacts of identified BMPs or programs are not discussed.

. Federal programs to be reviewed for consistency are not listed.

. Attorney General certification is not discussed.

. No public comment procedures are discussed.

In addition, the report does not address Region V concerns such as projects targeted at Lake Superior or in-place pollutants.

While the report is deficient in these respects, it succeeds in others:

. It lists 63 Best Management Practices and correlates them with appropriate source categories.

. It describes programs within ten nonpoint source categories.

. It lists current funding sources where known and identifies annual targets for a few programs.

. It places NPS programs within a framework. While the overall structure is clearly stated, the roles of the state Water Resources Committee and the MPCA are not. It is not clear where the nonpoint management strategy fits into statewide water quality administration.

1. BMPs identified:

The report lists 63 practices and associates them with 14 appropriate nonpoint source categories. The BMP selection process occurs in a series of clearly defined steps. Among the factors to be considered are suitability, cost, effectiveness and reliability. Groundwater impacts are not discussed.

2. Programs identified:

A variety of local, state and federal programs are identified according to each of ten nonpoint source categories and two special ones: crop production, animal wastes, pesticides and fertilizers, urban runoff and infiltration, construction sites, individual sewage treatment systems, hydromodification, silviculture, mining, highway de-icing, special erosion problems, and land disposal. The nature of each source and the adequacy of current programs are not discussed.

Funding sources are identified for the crop production and animal waste programs but not for most of the other categories. Four-year program goals are listed for some of the programs, but they are stated generally without annual objectives. Many of the goals are stated simply as a continuation of current activities.

Programs are not identified for atmospheric deposition, in-place contaminants, navigation and recreational boating and urban pesticide and fertilizer use.

3. Groundwater impacts:
None is identified for BMPs.

4. Funding sources:
Appropriate federal, state and local sources are listed for current crop production and animal waste programs. The CWP and the federal Clean Lakes programs will provide funds at for state level projects, but since demonstration projects are not identified, no additional funding sources are listed for specific efforts.

5. Federal program review:
None is listed.

6. Four-year timetable:
CWP goals are identified through 1989. Some program goals are identified although most consist of continuing activities.

7. AG certification:
Not listed.

8. Watershed demonstration projects:
Projects will be identified through the CWP program. Since that effort is locally driven, no effort is made to identify critical wellhead or reservoir areas for future projects. Sec. 319 funding is not listed for such efforts, and as a result, the report does not make a case for future appropriations.

9. Region V requests:
Not discussed.

10. Compliance with Sec. 319:
Although the state assessment report largely complies with 319, the management report falls far short. It succeeds in listing current programs and discussing a state level management framework. However, the assessment plays no role in identifying critical areas for potential demonstration projects. The report fails to address three of the six requirements and is deficient in two of the other three.

In short, the report identifies current programs without the coordinated future management program sought by Congress and the USEPA.

## Ohio

### Summary

Ohio EPA has developed a comprehensive NPS report which describes every river basin in the state. Drawing from over ten years of previous water quality survey work, the report includes detailed descriptions of the waterbodies affected by nonpoint sources and of appropriate categories. Those categories rank waterbodies by the presence of point and nonpoint source impacts as well as by the quality of evaluated and monitored data.

Monitored data consists of recent chemical and biological recording station information. Evaluated data consists of surveyed professional observations. NPS impacts are also summarized in the 305(b) report.

Despite the thoroughness of this first comprehensive assessment effort, several problems are apparent. First, the numbers do not appear to be internally consistent. The sum of affected streams (Part Vlll, p. 1), for example, does not add up to 100%. In addition, the sum of partial use and threatened stream miles (15,786) is considerably larger than the miles listed as included (61.3% of 21,000, or 12,873). The portion of streams assessed cannot be verified since, for some basins, total stream miles are not reported.

Perhaps a more serious problem is the lack of a precise definition for nonpoint pollution. The assessment report leaves this definition vague but notes that it includes habitat modification as well as runoff from various sources: mines, urban areas, landfills, farm fields, and forestry practices. The 305(b) report does not clearly define nonpoint either, but appears to generally limit the term to agricultural sources.

The assessment also fails to list the causes of water quality degradation associated with nonpoint sources. (Stream segments are listed with impact causes in Vol. II of 305(b)). Since aquatic life use serves as a broad indicator, it says little about parameters such as dissolved oxygen, sedimentation, excess phosphorus or concentrations of toxics. It is not clear how point and nonpoint source impacts were distinguished.

As would be expected, the assessment level varies from basin to basin. For example, the Cuyahoga basin has all of its stream miles assessed whereas the southeast Ohio River tributaries have only a 39% assessment level. Still, more than half of the unassessed waterbodies are suspected of having NPS impacts. Although future assessments will evaluate these areas, no timetable is presented for that work.

Information about particular basins and waterbodies is contained in three separate portions of the report. Those portions reflect impact source categories, waterbody priority rankings and degree of impact. The nature of this presentation complicates the analysis of particular waterbodies by scattering information on individual stream segments. The lack of a quantitative summary adds to the difficulty of evaluation. Nevertheless, the ranking system has an advantage. It allows future state and federal funds to be targeted to the most reliably documented NPS impaired waterbodies.

Despite some discussion of the state's wetlands protection program, no NPS impacts to these important waterbodies are discussed.

Agricultural practices and mining activities (coal, oil and gas) account for the most impacted stream miles. Stream channelization, waste disposal and urban land uses impact stream miles in descending order. Forestry activities affect a minor number of stream miles.

The report includes a process for evaluating best management practices (BMPs) and identifies federal, state and local programs for addressing NPS pollution. While OEPA has responsibility for planning water quality improvement programs, the Ohio Department of Natural Resources coordinates implementation with local jurisdictions. Landowner participation in NPS pollution abatement efforts is voluntary.

1. Standards:

Ohio EPA's NPS impact standards vary with respect to the type of water body being assessed. Stream segments are judged on their ability to meet a designated level of aquatic life use based on OEPA procedures. If adequate data do not exist, other evidence of NPS impacts is used. Such evidence can lead to a finding of suspected but not documented impact.

A reduction in the level of aquatic life leads to a listing in one of eight categories of impaired or impacted streams. Impacted streams have reduced aquatic use based on professional judgment, and impaired streams have reductions based on quantitative monitoring data. Thus streams are distinguished by data reliability and not by the severity or nature of the problem. The procedure used to determine use and the parameters measured are not described.

Lakes included in the report are limited to those larger than 20 acres. They are assessed according to a list of 13 indices known as the Lake Conditions Index (LCI). Of those 13, seven indices reflect NPS conditions and a documented impact on three or more of the seven leads to a "targeted" classification.

Groundwater aquifers are divided into those with known and those with suspected problems. Reflecting the lack of comprehensive knowledge about geochemical groundwater processes, the report does not to use a single standard in this area.

2. Sources of impact information:

Existing chemical and biological data (not identified), determined through on-site inspection and modeling, provide the main basis for determining impacts. The information was reported on survey forms developed by OEPA and sent to over 200 state, local, and federal agencies and academic institutions.

In addition to already gathered data, the report uses visual inspections, documented knowledge of specific impacts (storm sewer outfalls, cropland drain tiles, forestry or mining practices), and other information. The report emphasizes the use of documented information over determinations made on the basis of professional judgment.

3. Waterbodies covered:

Streams, lakes and groundwater aquifers are included in the report. No information on wetlands is presented, but the report notes that the ODNR is assessing the state's remaining wetland acres. Lake Erie is discussed in 305(b) but not in the NPS assessment.

4. Source categories:

The report categorizes stream impact sources in six classes: agriculture, silviculture, hydro-modification, urban, land disposal and resource extraction. Those classes are further divided into subcategories, such as storm sewers, livestock or crop production, road construction and forest management. Acid deposition and in-place contaminants are not explicitly included. Lakes are classified by their location on NPS affected streams and their analysis according to the Lake Conditions Index. Specific lake impact sources and pollutants are not discussed separately from streams. However, lakes independent of affected streams are listed separately, but, again, sources and pollutants are not included.

Known and suspected groundwater impacts are described by source category, particular pollutants and location.

All three waterbody classes are described in each basin narrative. The result is a comprehensive overview of stream, lake and groundwater impacts and correlations among them.

5. Impact categories:

The report does not correlate impacted waters with the causes of degradation. The parameters included in chemical and biological monitoring records are not listed.

6. BMP selection process:

The report describes the elements of a BMP selection process. That process uses a questionnaire to evaluate practices and rank them according to their impact on the particular NPS problem, effects on other pollution problems and how easily they can be implemented. Other factors include cost effectiveness, public participation, geographic applicability and maintenance.

The report does not say whether or not this process has ever been used or how it would fit with procedures in other agencies. It does note, however, the need for an interagency mechanism to coordinate the goals and strategies of relevant local, state and federal agencies.

7. Other programs:

The report lists and describes six federal, four state, five regional, four local and three academic institutions with NPS related programs. While the description is comprehensive and detailed, it does not attempt to integrate Sec. 319 funds into the program matrix.

8. Public review and comment:

Although not discussed in the narrative, the public comments and OEPA responses are included in the appendix. Written comments were sought over a 54-day period starting Jan. 31, 1988, and the report was presented in public meetings held March 1.

9. Issues:

The report includes no information on wetlands. While the complexity of wetland systems makes their evaluation time consuming, future assessments could recognize the extent of remaining wetland acres as inventoried by the Fish and Wildlife Service. Evaluations could proceed on the most highly valued wetlands as determined by wildlife use, proximity to highly used streams and lakes or flood control function.

A description of streams by contaminants is contained in Vol. II of the 305(b) report. However, the NPS priority rankings do not appear to take contaminants or their importance into account. The NPS Assessment could describe the procedure for determining aquatic life use attainment, the measured parameters, and their levels of statistical significance.

10. Milestones:

The report calls for completing Ohio's NPS assessment in four years. Specific year by year goals could be generated for inclusion in agency budgets and staffing plans. Since NPS impacts can be studied at various levels of detail, the purposes for which the assessment is to be used could be clearly spelled out.

11. The extent of NPS pollution:

The 305(b) report lists about 44,000 total miles of streams in Ohio and about 134,000 acres of lakes larger than five acres. Of the streams, 15,786 miles show partial or threatened aquatic life use from the following NPS sources:

. Agricultural activities affect 47% of the impaired stream miles by increasing sedimentation, modifying stream channels, and increasing nutrient and pesticide loads.

. Mining activities affect about 19% of impacted streams by increasing acidity and concentrations of metals.

. Urban land uses affect about ten percent of impacted streams with sediment, nutrient and toxic chemical runoff from construction areas, streets and storm sewers.

. Waste disposal affects about 12% of impacted streams with runoff from landfills and septic tanks.

Lakes are not classified by NPS sources, but altogether, about 243 Ohio lakes totaling about 113,000 acres show partial or threatened aquatic life use from NPS pollutants. A total of 124 lakes have been targeted on the basis of NPS impacts to three or more sensitive parameters.

Although the report lists cases of suspected and known groundwater impacts statewide, the extent of NPS impacts is more uncertain than it is for lakes and streams. The lack of comprehensive groundwater information means that an assessment cannot be expressed in the same terms used for other waterbodies. Moreover, sources of well contamination are often difficult to establish. As a result, the report discusses the nature of aquifers and the associated land uses which could affect them. Ohio contains both consolidated and unconsolidated aquifers, some of them close to the surface and unprotected by overlying clay soils. Such aquifers are vulnerable to leaching from surface activities. Altogether, the report lists cases of groundwater pollution from 60 counties.

## Ohio Management Plan

Ohio methodically addresses each of the Sec. 319 management report requirements within the context of eight nonpoint source categories. For each source type, the report describes current programs, groundwater impacts, funding levels, new efforts and an annual timetable for implementation.

Put together by an inter-agency task force sponsored by the Ohio Department of Natural Resources, the report also details a philosophical foundation for the entire NPS program. It calls for $2 million to $6 million in new state funds and a coordinated statewide approach to nonpoint pollution abatement.

However, the report does not identify specific abatement projects or priority watersheds which will be targeted by nonpoint funds over the next four years. Instead, it outlines a process and timetable for selecting such projects. Various state and local agencies will be surveyed for proposals, and a list of fundable projects will be submitted to USEPA in February, 1989. Project selection would depend on ten criteria which include anticipated water quality improvements, the value of the targeted waters, the degree of local support and consistency with the state Water Quality Management Plan.

The report ignores that portion of EPA Region V Guidance (Dec. 1987) that calls for projects associated with public water supply reservoirs, lakes or wellheads.

As a matter of state policy, implementation authority is left largely with existing programs at the local level. Counties, municipalities and special purpose areas such as Soil and Water Conservation Districts would continue to operate their own programs but would focus more strongly on water quality.

At the state level, the ODNR and the Ohio Environmental Protection Agency are designated as the lead administrative agencies in NPS management. The OEPA's nonpoint source assessment report would be used to target federal and state nonpoint funds. That document uses a top-down approach by ranking lakes and streams statewide by data reliability, the level of aquatic life use and the presence of point sources. Managers could use the rankings to focus projects on waters reliably known to have impacts from nonpoint sources.

The management report thus implies a two-tiered approach to pollution abatement: one operating within existing programs and another based on statewide priorities.

Most programs would continue to be locally administered. Although state guidelines would set minimum criteria, regulation would follow local ordinances and depend on local enforcement. Some sources are nevertheless regulated at the state level. Land disposal, oil and gas wells and mining are handled by state and federal agencies.

The report recommends a variety of new efforts, ranging from one-time conferences to comprehensive new program authority and watershed demonstration projects.

While the report meets the 319 requirements, it does not address Region V requests on such matters as Great Lakes programs and in-place pollutants. Perhaps more importantly, coordination with the state water quality plan is not discussed. It is mentioned only as one of the criteria for ranking project proposals. As a result, the report fails to place the many NPS programs into a broad integrated framework.

1. BMPs identified:

A variety of best management practices are identified for each source. As listed, they range from broad scale planning activities and pest management strategies to construction techniques and equipment design details.

BMP effectiveness is discussed within several categories, and the report makes clear the need to develop new practices to control such sources as brine disposal from oil production, urban runoff and acid mine drainage. In contrast, methods for controlling contamination from farming, timber harvesting and construction appear to be well developed. Proper regulation in those areas appears to be a political, not a technical issue.

Some of the BMPs listed are themselves potential sources of contamination. For example, additional excavation of surface mines can be useful in managing mine runoff, and carefully directed stream dredging can help establish new fish and wildlife habitat. Clearly, as the report notes, all practices must be tailored to the site and the watershed management goals.

2. Programs identified:

As noted above, Ohio's current programs are categorized by pollution sources. Management efforts will be analyzed accordingly.

**Agricultural efforts** focus on erosion, fertilizer management, livestock wastes, and pesticides. They involve five state and three federal agencies which share at least 23 separate programs. Farming activities affect the most stream miles and lakes of any nonpoint source, but with a few exceptions, program participation is voluntary. Educational initiatives, regulatory inspections, cropland set-asides and cost sharing for improvements constitute the bulk of current management tools. Funding levels range from volatile for most to stable for some. Most vary with economic trends.

Standards are well-developed for many activities (fertilizer application, pesticide handling, manure management), and there is interest in alternative practices such as composting, stream buffer strips and field tailored fertilizers. However, economic factors tend to determine participation rates in voluntary programs.

Some efforts are presently ineffective. For example, livestock waste can be regulated as a point source under specific conditions, but when the conditions are not met, the state has limited regulatory authority. A technical advisory committee has recommended stiffer fines for pollution violations, mandatory management plans for new facilities and consistent program funding.

**Construction site runoff** in Ohio is managed by local governments, but the report notes that current standards, funding and implementation are weak. Per acre yields of sediment are higher for this category than for any other, but efforts to control runoff are not generally enforced.

The ODNR Division of Soil and Water Conservation has proposed state standards for site erosion controls, but at present, the standards are deemed inadequate. They ignore impacts to fragile areas and do not recognize some effective measures.

Statewide, 24 counties, 63 municipalities and 6 townships have adopted construction site erosion ordinances, but enforcement is described as spotty at best.

Among the recommendations are new training sessions, enforcement of minimum standards and review of existing agency standards for consistency.

**Hydromodification** consists of a broadly defined set of activities which alter stream channels. Such activities include dredging, channelization, streambank modification, and dam and bridge construction. These activities are carried out for a variety of purposes and have both short and long term impacts. They also modify the behavior of pollutants from other sources.

No agency programs address these activities in a comprehensive manner. The U.S. Army Corps of Engineers and the ODNR have developed standards for several kinds of in-stream development. The Soil Conservation Service and the U.S. Fish and Wildlife Service have also published technical documents to guide riparian activities.

The report identifies a total of 17 relevant programs in ten federal, state and local agencies.

Recommendations include technical assistance to local governments, updated project review criteria, expanded floodplain management and wetlands conservation.

The report ignores two potential sources which could fall into this category: recreation and navigation. Both can lead to sedimentation and contamination by bacteria and toxics. Out-of-state examples include barge navigation on the Mississippi River and the presence of boat hull anti-fouling agents in Chesapeake Bay.

**Land disposal** activities fall into five specific categories: hazardous waste, injection wells, landfills, on-site sewage systems and sludge spreading. Regulatory programs include permitting, standard setting and inspection activities for each area.

Most programs in this category fall under USEPA and Ohio EPA authority. The Ohio Department of Health has responsibility for on-site sewage systems.

The report recommends a variety of activities in each area, including identification of existing health threats, development of a waste minimization program and encouragement of alternatives to landfilling such as source reduction, recycling and incineration. Also suggested are routine inspection of septic systems and hydrogeologic assessments for sludge spreading.

**Mining** impacts and reclamation activities are regulated by two state and three federal agencies. The ODNR's Division of Reclamation issues permits for mining operations, but the OEPA regulates sediment pond discharges as point sources. A State Reclamation Committee coordinates state and federal reclamation of abandoned mine sites.

The report cites acid drainage and sedimentation impacts to over 1,400 stream miles. This figure has been roughly doubled by the NPS assessment which identified 2,929 miles of streams (by this author's calculation) affected by all resource extraction activities. Most of those are mines.

Program recommendations cite the need for additional public education, staff training, site maintenance, research, and data base development.

**Oil field waste regulation** is coordinated by the ODNR's Division of Oil and Gas. Responsibilities are shared with the Department of Industrial Relations and the OEPA. As an industrial activity with well-defined procedures and standards, oil and gas production has a 100-year history of state regulation. However, water quality concerns have been addressed only since the mid-70s.

The ODOG conducts permitting, technical assistance and enforcement efforts with USEPA oversight. Among the activities with potential NPS impacts are brine disposal (by well injection, annular disposal or road spreading), well abandonment, site erosion and brine and oil storage. Impacts range from sedimentation to contamination of surface and groundwater by brine and associated contaminants.

Recommendations focus on a variety of efforts, including mechanical improvements, proper regulatory enforcement, public education, research on brine disposal impacts and a ban on road spreading of brine.

**Silviculture** is not regulated in Ohio. Since current programs are advisory, activities are conducted in response to citizen inquiries or complaints. Little information exists to document nonpoint impacts from tree harvesting, road building or pesticide application.

Local conservation districts and the ODNR's Division of Forestry both provide landowner assistance, and at the federal level, the SCS and the U.S. Forest Service provide additional technical information.

Recommendations include giving the Division of Forestry authority to develop a NPS program consisting of coordination, implementation and monitoring of BMPs. Also suggested is a regulatory program calling for the involvement of licensed professional foresters in commercial harvesting operations.

**Urban runoff** controls are not widely used in Ohio, but many federal, state and local agencies directly address urban pollution concerns. Four federal agencies, USEPA, FmHA, SCS, and US Army Corps of Engineers are responsible for activities ranging from housing project design to watershed improvement. State programs range from highway maintenance by the Department of Transportation to pending point source regulation of stormwater by the OEPA. Local governments which carry out a variety of construction projects and land management activities could include BMPs in their plans.

Since no programs specifically address urban runoff, the report recommends forming a task force to set standards, identify funding and research needs, and develop legislative priorities. State efforts should be coordinated with the National Stormwater Permit Program. Two major initiatives suggested are statewide floodplain zoning and riparian buffer zones.

3. Groundwater impacts:

Potential groundwater impacts are discussed for each program category. In general, BMPs are considered in relation to infiltration rates and their ability to introduce contaminants into aquifers.

Uncertainty pervades this subject, and many of the research needs focus on groundwater. In some cases, the report recommends careful hydrogeologic evaluation of sites for groundwater vulnerability. Some programs, such as waste disposal and oil field regulation, focus specifically on groundwater protection, although some activities continue despite open questions about their groundwater impacts. These activities include brine spreading on roads and the use of retention ponds to control urban runoff.

4. Federal funding sources:

Federal, state and local funding sources are listed for each program in each source category. The report calls for existing funding sources to take water quality goals into account and thus help meet Sec. 319 abatement goals.

Potential funding sources are not listed for demonstration projects and new efforts. The proposed new state fund and future federal 319 money could apply to such efforts, but the state needs to make a well developed case for legislative consideration.

5. Federal program review:

Appropriate federal programs are identified for each source category.

6. Milestones:

In most cases, timetables identified for future planning and implementation are listed as annual targets. Given the uncertainties in funding and legislative priorities, this strategy seems reasonable, but more precise identification of program milestones could lead to a more precise budget plan.

7. AG certification:

The ODNR has submitted the report for the Ohio Attorney General's review.

8. Watershed demonstration projects:

The report outlines a process and timetable for the identification of projects for funding consideration in 1989. That process calls for agencies to consider nonpoint source abatement projects in waters listed in the assessment report priority categories. Proposals are to be ranked according to ten criteria. The report does not use the assessment to target critical watersheds or waterbodies.

9. Region V requests:

Region V requests are not discussed in the report.

10. Compliance with 319:

The report complies with Sec. 319 requirements but is inadequate in several respects. It fails to identify specific projects or describe a coordinating mechanism for existing programs. It does not address program integration with the state water quality management plan. It does not address sources such as atmospheric deposition or in-place contaminants.

Nevertheless, the report does outline a process and timetable for demonstration projects. It identifies critical management issues and provides a sound basis for the integration of Ohio's presently fragmented nonpoint source efforts.

To fully comply, the report needs to address potential projects and coordination with the same thoroughness it uses in discussing each source category and current programs.

## Wisconsin

### Summary

Wisconsin has met Sec. 319 requirements by updating existing NPS data and compiling a table on stream impacts on a watershed basis. The table describes impacts by the number of stream miles (not location), and NPS pollutant sources are broadly categorized in six areas: three agricultural activities, construction, urban impacts and mine tailings.

In addition, the Wisconsin Department of Natural Resources addresses nonpoint issues in its 305(b) report. It notes that NPS pollutants affect about three-quarters of the state's lakes (p. 14) and have replaced point sources as the major cause of water quality degradation.

The reports do not cover wetlands. No goals are outlined for assessing those waters, but the report notes that the WDNR recently acquired a U.S. Army Corps of Engineers wetlands assessment strategy. Implementation is not discussed.

Lakes sensitive to NPS pollutants are listed in a separate table, but they are not assessed for level of use attainment, pollution sources or contaminants. An analysis of actual lake impacts will be carried out for the 1990 assessment.

The report presents groundwater information with narrative accompanied by additional tables and figures. The discussion focuses on major contamination sources as determined through chemical spills, average nitrogen soil loadings, and investigations of polluted wells.

The long and medium 304(l) lists for streams and lakes also reflect NPS contamination, but they do not go beyond a general recognition of the problem.

Several problems with the data are apparent. The report contains inconsistencies in watershed codes. The Lower Wisconsin River codes do not correspond with those on the locator map. Several portions of coded watersheds are missing.

In addition, the total for miles impacted does not correspond to the totals broken down by source categories (last page of table 1). If miles impacted represents a different level of degradation, that should be explained.

Finally, total stream miles included in the assessment (47,184) varies significantly from the total stream miles (43,600) in the state as reflected in 305(b).

Those river basins identified as unassessed on the report comprise about 30 percent of the state's stream miles.

1. Standards:

Wisconsin uses the designated use standard. However, the report describes neither the basis for judgments on the level of use supported nor the different use types (fishing, swimming or aquatic life use). Water quality standards are neither described nor referenced.

2. Sources of impact information:

The department used previously collected information from the 1985 ASIWPCA assessment, water quality management plans and updates, and NPS priority watershed plans. WDNR staff reviewed information on watersheds in which they worked. No inter-agency effort to collect additional information is described.

3. Waterbodies assessed:

Streams, lakes and groundwater are included. No impacts are listed for wetlands which are listed as an inadequately addressed resource.

4. Impact source categories:

Impacts are divided into six broad groups, but more specific listings are lacking. It cannot be determined what sorts of urban sources, for example, contribute to that category. Their relative importance is not shown. In addition, sources such as landfills, highway maintenance, acid deposition, in-place contaminants, silviculture and radioactivity are purposely not included. Sludge spreading and landfill issues are handled as point sources, but problems with other sources such as failing septic systems are not discussed.

Atmospheric deposition is addressed by Wisconsin's air management program.

5. BMP selection process:

Detailed standards and procedures for selecting BMPs are contained in administrative rule NR 120. The practices eligible and ineligible for cost-sharing are also discussed. BMPs are selected through priority watershed plans.

6. Other programs:

The report discusses the state's 1979 NPS pollution abatement program. That effort is administered by both the WDNR and the state Dept. of Agriculture, Trade and Consumer Protection. Administrative responsibilities are being rearranged according to a transition workplan submitted with the assessment report. The assessment references the detailed discussion of state and local programs in the Management report.

7. Public review and comment:

Along with the draft management report, the assessment report was to be reviewed in June by the Chapters 144 and 92 revisions advisory committee. That group is composed of about 60 members of groups concerned with nonpoint pollution issues.

Press releases were to announce the report's public availability June 15 with comments to be received for a one month period. The August 1, 1988 assessment draft does not verify publication or include any discussion of comments received as a result of the notice.

The NPS Management Report notes that about 1,000 organizations and individuals were contacted during development of the assessment. Their comments are summarized in the management report.

8. Milestones:

Wisconsin updates its watershed plans every five years. The report includes a schedule for basin updates through 1992.

Refinements to the lake and stream assessments are planned as part of each basin update.

9. Issues:

The report identifies areas not adequately addressed (p. 3). They include NPS impacts on the state's boundary waters, wetlands and endangered resources. The report also calls for greater attention to pesticide impacts on groundwater and to impacts of nonpoint derviced toxic chemicals on Great Lakes biota.

Although not relevant to the assessment requirements, the Management Report identifies 14 concerns which need consideration in future assessment programs. Among them are NPS groundwater impacts, BMP evaluation, habitat impacts, a statewide monitoring strategy, model evaluation and an assessment of cranberry production impacts. Such concerns reflect Wisconsin's experience with nonpoint issues. They also highlight needs fundamental throughout the region.

Nevertheless, to fully meet the Sec. 319 requirements, the WDNR needs to:

. Identify the basis for use attainment designations and the NPS related causes of water quality degradation.

. Assemble data in a format compatible with the WBS framework.

. Identify impacts to Great Lakes coastal waters.

. Report impacts from sources excluded in the 1988 report. These include categories such as sludge disposal, accumulations of toxics, landfills and sand and gravel pits.

10. Extent of NPS pollution:

NPS pollution is the dominant cause of non-support in Wisconsin's lakes and streams. According to the 1988 305(b) report, it affects 90% of the non-supported lakes and 98% of the non-supported streams.

However, well over half of the state's streams are described as full support. Almost 28,000 miles are classified as supporting full uses, while another 10,000 miles support them but are threatened. In the partial use category, the WDNR has classified 8,249 miles, and 1,082 miles do not support designated uses.

The state's lakes are more heavily impacted by NPS pollution. About 80% of them are NPS degraded, and only seven percent are classified as fully supporting. Judged on the basis of the number of lake acres assessed, the state has lost the use of 25 percent of its assessed lake acres to NPS impacts. About half, 49 percent of assessed lake acres, offer partial use while the remaining are threatened (18%) or full use (7%).

As in the other Great Lakes states, agriculture is the dominant cause of NPS pollution. It impacts 14,589 assessed stream miles, while urban impacts affect 754 assessed miles. Impacts from silviculture are not listed, and construction and mine tailings impacts are considered minor.

Groundwater contamination is distributed around the state for a variety of pollutants. While pesticide contamination is concentrated in the central part of the state, VOCs have been detected statewide. The report also notes that injection wells which put stormwater and heat pump outflows into the groundwater pose an additional contamination threat.

While the report does not discuss the Great Lakes coastal waters in detail, the state's 1986 water quality reported notes that about 70 percent of those miles are also degraded by nonpoint pollution.

## Wisconsin NPS Management Plan

The Wisconsin Dept. of Natural Resources' management report describes Wisconsin's current NPS program and pending changes to it. It discusses programs at all governmental levels and addresses most source categories recognized by USEPA, although several are left out.

As described, Wisconsin's current framework exists at four well-defined levels. At the bottom are individual rural or urban projects using specified Best Management Practices. These efforts include work done under existing agency programs as well as the Priority Watershed program.

Standing above those efforts is a second tier composed of priority watershed plans. As the prime planning tools for NPS efforts, these documents identify the most appropriate practices to be used under conditions within the watershed.

The third level is formed by the Water Quality Management Plans which the WDNR updates for every basin on a five year rotation.

At the highest level are state and federal agency coordination arrangements. With the DNR and the Dept. of Agriculture, Trade and Consumer Protection (DATCP) directed to share responsibility for NPS reduction efforts, these arrangements have recently become more complex. While the DATCP has responsibility for implementing ag-related programs, the DNR is the lead agency for urban and non-farm efforts. MOU's are included in the appendices.

In addition to describing this framework, the report discusses issues not adequately addressed in Wisconsin. Each issue clearly outlines management needs and proposed institutional responses to them. Each could contribute to the overall program's future direction.

The report includes a discussion of NPS impact assessment procedures. They form the basis for determining the nature and severity of impacts and thus help formulate watershed specific reduction efforts. The procedures include groundwater assessment and several kinds of surface water monitoring. Along with those efforts, inventories are routinely conducted for several sources including animal feedlots, manure spreading and streambank erosion. Procedures are being developed for two sources, upland runoff and urban areas.

Nevertheless, no role is described for the WDNR's 1988 Sec. 319 assessment report in the state abatement program. As described on page 30 of the management report, comprehensive watershed assessments are carried out as part of the NPS Pollution Abatement Program.

The report meets the USEPA's suggested demonstration project focus by describing the following efforts:

. Evaluation of lead/arsenic levels in former Door County orchards.

. Evaluate and clean-up water quality problems caused by mining wastes in southwest Wisconsin.

. Formulate projects within Great Lakes Areas of Concern.

Each of the proposed projects demonstrates significant non-point problems and offers the potential of water quality improvements. Although the WDNR has studied these problems to some extent, no proposed timetables or funding sources are included. The Door County project involves potential drinking water contamination.

While the report provides a substantial view of Wisconsin's ongoing and future NPS program, it falls short of meeting the Sec. 319 requirements in several respects.

First, as noted earlier, it does not describe the role of the statewide assessment in the priority watershed program. The assessment would be useful in targeting state and federal funds, but it is not included as part of the watershed selection process.

Second, the report does not include a projected timetable or source of funds for the watershed demonstration projects. Such an inclusion is specifically called for in USEPA Guidance and would help to justify future Sec. 319 appropriations.

Third, although some identified programs target specific sources (animal waste management, septic tank regulation), the report does not describe programs by sources identified in the 1988 assessment report. The adequacy of the overall state effort is not clear.

Fourth, the report does not discuss federal funding sources, the groundwater impacts of BMPs, or certification by the attorney general.

1. BMPs identified:

Best management practices are discussed for agricultural, urban and construction site sources. The report identifies 16 farm practices and 22 measures to reduce erosion from construction sites. Although urban measures are discussed in general, none is listed. Groundwater impacts are not considered.

Statutory conditions for BMP cost-sharing are listed in the appendices.

2. Programs identified:

The report lists only state programs. These include the Nonpoint Source Pollution Abatement Program, several DATCP soil and water resource management programs, water quality management plans and the toxic materials management program. Lake management and groundwater protection efforts are also included. Local and federal programs also need to be considered and coordinated with the state level effort.

Wisconsin has spent far more money than any other Region V state on nonpoint efforts. In the last ten years, a total of about $34 million has been channeled through the Nonpoint Source Pollution Abatement Program alone. During the current fiscal year, the legislature appropriated $6.732 million for the WDNR's abatement program.

3. Groundwater impacts of BMPs:

While groundwater issues are discussed at length, no specific groundwater impacts are identified for BMPs. The report calls for additional research into this area.

4. Funding sources:

Funding sources such as 205(j) and Sec. 319 are noted in passing, but no effort has been made to list funding sources with programs.

5. Federal program review for consistency:

A total of 44 programs are listed in 15 federal agencies and departments. The U.S. Forest Service, Dept. of Commerce, Dept. of Defense and the National Ocean and Atmospheric Administration are listed for review although no programs are listed in them.

6. Milestones:

None is listed for the demonstration projects. Projected timetables are listed for the priority watershed projects.

7. AG certification:

Not addressed.

8. Watershed demonstration projects:

The report describes the three projects identified above. Although Wisconsin went further than most states in meeting this element, the discussion lacks consideration of a timetable or funding. Developing these proposals further will help justify future Sec. 319 appropriations requests.

Areawide water quality management plans will help identify future Sec. 319 demonstration projects.

9. Region V requests:

Several Region V requests are addressed. The report discusses NPS controls in the context of the areawide water quality management plan framework, but the relative priority of non-point efforts within each is not addressed. Since the plans also focus on point sources and the many designated uses for Wisconsin's water resource, the NPS program role needs to be described.

Great Lakes concerns are discussed as an element of the watershed demonstration projects.

Memoranda of understanding are included between the WDNR and the Wis. Dept. of Transportation, between the USDA and the WDNR, between the SCS, the DATCP and Green Lake County, and between the DATCP and county land conservation committees.

10. Compliance with 319:

While the report offers a detailed view of how Wisconsin's NPS program is operated and where it is headed, it fails to meet Sec. 319 requirements in the following respects:

. BMPs are not identified for hydromodification and resource extraction sources, both of which are included in the assessment report. In addition, urban BMPs were said to be listed in Table 3 but are missing. BMP groundwater impacts are discussed among inadequately addressed issues for the management of pesticides, urban runoff and road salt.

. Programs are not listed according to the source categories identified in the 1988 assessment report. As a result, the adequacy of Wisconsin's effort to address each source can be stated only for targeted programs. For example, the current status of urban runoff or construction site erosion management is unclear. No programs are identified to address those sources. Still, the report notes the Clean Water Act provisions for permitting stormwater discharges, a program which targets urban sources. In addition, two critical sources, failing septic tanks and leaking fuel tanks, are not discussed in the assessment, although programs administered by the Wisconsin Department of Industry, Labor and Human Relations are referenced. Atmospheric deposition efforts may be included in future NPS reports.

. No milestones are set forth for program development or demonstration projects.

. Attorney general certification is not addressed.

. Funding sources are not listed for the implemention of programs or projects.

. Although public input was sought to develop the management report, comments on the final report are not addressed.

Nevertheless, the report reflects Wisconsin's NPS management experience which extends back more than ten years. The issues identified are relevant to programs in all states. They comprise a significant body of unresolved questions which, to be effective, future programs will have to answer. Targeting projects to address prioritized issues, in addition to critical waters, will help justify future Congressional funding requests.

## Clean Lakes Reports

Sec. 315 of the Water Quality Act of 1987 requires the states to:

. Identify and classify by eutrophic status all publicly owned lakes in the state.

. Describe lake pollution control methods.

. Describe control methods to be carried out with federal agencies.

. Describe methods of reducing high acidity and related concentrations of toxic substances.

. List publicly owned lakes known to be impaired.

. Describe water quality trends in the state's lakes.

Each of the states has addressed these requirements differently. Nevertheless, the problems and the strategies for addressing them are directly related to nonpoint source pollution management. The following discussion is included to provide perspective on a particular nonpoint effort, the Clean Lakes Program.

### Regional analysis - Clean Lakes

The Region V states have addressed Sec. 314 with varying levels of thoroughness. Indiana and Ohio put together separate reports on lake management, while the other four states incorporated the required information into their 305(b) reports.

Illinois, Michigan and Minnesota complied with the Clean Water Act's lake provisions most completely. Their reports list lakes by all the required characteristics, describe appropriate programs and note data gaps.

Ohio's report also deals with all of the Sec. 314 elements. However, Ohio does not have the programming base evident in Michigan, Illinois and Minnesota. The lack of an Ohio lakes program has resulted in little information on pollution control strategies, restoration efforts or water quality trends.

Wisconsin's report reflects past assessment efforts and a recently established lakes program. However, efforts to compile information into a format consistent with Sec. 314 were apparently not made. The Wisconsin Department of Natural Resources notes that it is seeking federal funds to update past lake studies.

Indiana largely meets the requirements but falls short of the program descriptions sought in the Act. Its report gives a broad overview of lake conditions and lists individual lakes by a variety of characteristics. However, it does not adequately describe the state's two-year old lake enhancement program or potential restoration efforts.

Indiana's report includes an interesting discussion challenging the commonly used Carlson trophic index. Since trophic status is one of the major factors in determining programming priorities, this discussion could imply changes in other states' programs.

1. Extent of lakes included:

Altogether, the states report information on about 4,397 lakes. Because each state uses a different standard, the reports do not reflect lakes included as a percent of all lakes in the region. Still, those assessed amount to roughly ten percent of all lakes over a minimum size. That size varies between five and ten acres depending on the state.

While the figures reflect a small percentage of total lakes, they account for the majority of lake acres. Again, inconsistent state procedures preclude calculation of a single reliable regional figure, but total lake acres in the reports appear to be well over half of the regional total.

2. Description specificity:

Each report except Wisconsin's lists specific lakes by essential physical characteristics including location, size, depth, trophic status and level of impairment. Wisconsin lacks data on trophic status and impairment. Illinois, Minnesota, Ohio and Michigan go further by including details on categories of use attainment, pollution sources, and causes of impairment. They report lake status as threatened or impaired, and each except Ohio has conducted a trends analyis.

Reports from Ohio, Indiana and Wisconsin lack at least one critical element. Indiana fails to describe levels of use attainment, pollution sources or restoration efforts.

Ohio notes that its final report will list lakes by trophic status, and for use attainment, the OEPA employs a Lake Conditions Index which incorporates a variety of parameters including trophism. Ohio does not have enough data to indicate water quality trends.

Wisconsin's report includes 96 lakes in the 304(l) lists and 1,084 in a list of NPS sensitive lakes. However, it does not list impaired or threatened lakes. The WDNR is seeking federal funds to update its lakes data base. Like Ohio, Wisconsin lacks data for a trends analysis.

3. Acid sensitivity:

Only the three northernmost states describe programs to assess lakes for acid sensitivity. While most lakes in the region are considered well-buffered by carbonate bedrock, some lakes in northern portions of Minnesota, Wisconsin and Michigan have little mineral inflow and overlie igneous or granitic bedrock. The Michigan report notes that low pH may have several impacts, including impaired fish reproduction and elimination of certain species.

Acid rain is also thought to be associated with high levels of mercury in sediment and fish. Researchers in Minnesota and Wisconsin are currently studying acid rain impacts and the strength of the mercury association.

Mitigation efforts currently center on reducing sulfur dioxide emissions from power plants in the three northern states. Wisconsin is investigating the possibility of pumping mineral bearing groundwater into sensitive lakes. While adding lime to lakes has been investigated, it is viewed as a temporary treatment of a symptom and not part of a long-term solution.

Indiana, Illinois and Ohio are not conducting acid rain impact studies or mitigation efforts. It is not clear whether or not such efforts would be considered if links can be demonstrated between activities within their borders and damage to acid sensitive lakes in other states.

Some lakes in Ohio, Indiana and Illinois receive acid drainage from mines, and the Ohio DNR has undertaken two restoration projects in such lakes. No other acidity assessment or restoration efforts are described.

4. Toxics assessment and management:

Consistent with the Clean Water Act's focus on toxics, each of the states describes efforts to monitor and evaluate accumulations of toxic chemicals. PCBs and mercury are the mostly commonly listed contaminants of lakes. Other heavy metals include cadmium, zinc, lead and copper. Monitoring is also conducted for pesticides such as chlordane, atrazine and alachlor.

Fish tissue and sediment sampling are used to assess the severity of contamination. Illinois and Wisconsin are also using bioassay effluent testing to assess point source discharges.

Research is being conducted in Michigan, Minnesota and Wisconsin on fish tissue accumulations and the patterns of PCB and mercury movement.

While many affected lakes have been identified, monitoring data are not complete enough in any state to reliably describe the regional extent of contamination. Still, known impacts range from restrictions on fish consumption to closed swimming areas, tumors in fish and deformities in waterfowl.

Other than dredging contaminated sediments, no reduction strategies are discussed in the reports. Dredging is explicitly avoided in some areas where additional mobilization is feared.

5. Pollution control approach:

All states describe aspects of their point and nonpoint source programs. Each is critical to lake management as well as rivers, wetlands and groundwater.

A variety of broader programs targets lakes specifically. These include Minnesota's Clean Waters Partnership Program, Indiana's lake enhancement program, Wisconsin's Lakes Management Program, and Michigan's Clean Lakes Program.

In Illinois, lake management is coordinated with other state programs by the state Water Quality Management Plan. The IEPA initiated a lakes program in 1977, and in October, 1987, a lake management workgroup was formed to coordinate efforts by different agencies.

Ohio administers a small lakes program through the Office of Planning Coordination.

6. Federal Clean Lakes assistance:

Federal funding has been crucial to restoration efforts in Minnesota, Illinois, Ohio and Michigan. Minnesota notes that its program relies on federal assistance. Nine federally assisted projects have been completed, and 17 projects are currently underway.

Each of the state reports except Indiana's and Wisconsin's describes efforts carried out under the program. In Ohio's case, since the state has no formal lakes program, the federal effort provides the program basis. In Illinois, four projects have been completed and four more are underway. In the last two years, Michigan has completed two Clean Lakes projects with documented improvements in recreational use and water quality.

7. Lakes impaired or threatened:

As part of the 305(b) reports, four of the states include lists of lakes which have uses that are either impaired or threatened. Indiana' 303(d) list and Wisconsin's 303(d) and nonpoint sensitive lakes lists also meet the requirement.

8. Water quality trends:

Data to reliably describe water quality trends are lacking in each state, and both Ohio and Wisconsin note that with current information, such efforts cannot be done. Minnesota provided the most thorough effort by showing statistical comparisons of data for nine different parameters. Illinois, Indiana and Michigan provided less comprehensive descriptions.

Among the problems with such data are differences in detection limits and reporting standards over time. The parameters of interest can also fluctuate according to random and poorly understood processes. Thus, differences in data may not be reliable for discerning long-term trends.

9. Comments:

**On report organization.** The integration of lakes information into the 305(b) reporting format not surprisingly varies from state to state. Generally, relevant facts on lake water quality, monitoring and programming appear in discussions on lakes themselves as well as on pollution sources and causes.

While Indiana and Ohio compiled stand-alone lakes volumes, Minnesota scattered relevant lakes information throughout various sections of its main report. Michigan, Illinois and Wisconsin focus 305(b) chapters on lakes and include most relevant data within them.

For evaluating compliance with Sec. 314, stand-alone reports provide the most easily analyzed format. They would also seem to lend themselves most effectively to state management programs.

Program elements can easily identified, and the basis for assessing and ranking individual lakes can be clearly related to determinations of impairment.

**On assessment basis.** Although a variety of water quality parameters are recognized in state regulations throughout the region, each state uses them differently for assessing lakes. Following is a summary of each state's basis for assessing lakes.

The Ohio EPA has developed an effective strategy for incorporating 13 water quality parameters and reducing them to one index number. Use determinations can be keyed to specific subsets of parameters, but the final Lake Conditions Index number (calculated with a weighting scheme) ranks lakes for future program purposes.

Michigan determines use levels by the rate of water quality standards violations and observed land and water uses. Standards reflecting 12 characteristics from turbidity to toxics were adopted in 1986.

Illinois uses an index similar to but not as detailed as Ohio's. The Lake Use Impairment Index reflects trophic status, macrophyte growth, and sediment conditions. Combined with water quality standards violations, the LUI is used to determine levels of impairment.

Minnesota uses a more subjective measure of impairment that focuses on swimming uses. User perceptions and parameters reflecting trophic status are combined to reach a determination of suitability for swimming. Fishing use is determined through analysis of fish tissue contaminants.

Wisconsin does not use a data consolidation scheme and instead looks to a variety of indicators of lake conditions. The WDNR includes violations of the state's five general water quality standards, toxics standards, cases of fish tissue contamination, fish kills, waters identified in 1985 as impaired by nonpoint sources, eutrophic waters, and waters identified in 305(b) reports from 1981 through 1986.

Similar to Wisconsin, Indiana uses a variety of criteria for assessing lakes. Trophic status, fish tissue contamination and weed growth are all used to determine use levels. Water quality standards are not summarized in 305(b) or the lakes document, but use determinations rest on such parameters as BOD, fecal coliform and levels of toxics. Indiana has established four lake categories for management purposes.

Among available lake indicators, Ohio's Lake Conditions Index seems to offer the most reliable measure for management purposes. Its flexibility and power of discrimination appear useful for a variety of regulatory programs.

**On NPS relevance:** Pollution control programs have focused on point sources since the early '70s, and several reports note that nonpoint sources (as defined by each state) have since become the major sources of contamination. Wisconsin contends that 90% of water quality degradation in lakes stems from NPS, primarily from agricultural activities. Similar assessments come from every other Region V state.

Minnesota's report demonstrates a positive association between eutrophic lake conditions and agricultural land uses. In Ohio, the 1988 NPS assessment targeted 124 lakes for exceeding criteria linked to NPS.

Lake improvements are thus directly linked to NPS control efforts. In many cases it appears they cannot be separated. In Minnesota, three lakes projects focus on nonpoint sources. All the lake restoration work in Illinois addresses NPS related problems including sedimentation, nutrients, weed growth and oxygen depletion. In Wisconsin, restoration has focused on nutrients in sediment and watershed improvements.

Although many accumulations of toxic chemicals may ultimately stem from a point source, their dispersal has led to their classification by USEPA as nonpoint. Atmospheric deposition, contaminated lake sediments, landfill leachate and stormwater runoff all carry a variety of toxics into lakes. In some states, these sources are regulated as point sources. Their successful control may require some programming accommodation between the states and USEPA.

**On support for state programs:** While all Region V states need federal funds for lake management, four states list federal support as a special concern. Minnesota, Michigan, Illinois and Wisconsin specifically call for a stronger federal Clean Lakes program with additional funding. In each case, the reports point out that these efforts should be linked to NPS controls as well.

Illinois notes that additional federal funds would be used to increase monitoring efforts.

Minnesota reports that by not receiving Clean Lakes funding in 1988, up to 15 projects may be in jeopardy and project schedules will be set back.

Wisconsin calls for funding to develop lake water quality standards and conduct monitoring.

Michigan reports that funding for its Clean Water Incentives Program is not adequate and that federal funding is critical for lake protection and demonstration projects.

Indiana and Ohio need federal funds to re-establish lake program activities.

## Illinois

### Summary

With detailed information on 382 lakes (74% of total lake acreage), the Illinois Environmental Protection Agency (IEPA) has addressed Sec. 314 in a thorough manner. The agency's 305(b) report describes lakes by trophic status, use and impairment levels, water quality trends, location, ownership, and pollution sources. It reviews the overall pollution control framework from monitoring and permitting to evaluation and enforcement.

The report does not discuss acid sensitivity in lakes, but the IEPA notes that the state's limestone bedrock is believed to buffer most or all lakes from acid deposition. The ambient lake monitoring program lists pH as a monitored parameter.

The report describes efforts to monitor both streams and lakes for accumulations of toxic chemicals. The fish tissue and sediment monitoring programs maintain permanent stations at 15 inland lakes. Highly elevated tissue levels of mercury, copper, lead, zinc, cadmium, PCBs and chlordane have been recorded in some lakes. While the report describes Illinois' pollution control system in detail, no mitigation or control strategies for toxic chemicals are discussed.

Altogether statewide, 58% of Illinois' assessed lakes are classified as eutrophic and 35% are hypereutrophic. Another 6% are considered mesotrophic, and 0.5% are oligotrophic.

Nevertheless, despite extensive eutrophic conditions, 95% fully support fishing uses and for swimming, 47% are fully supporting.

1. Lake identification and classification:

The report lists lakes by many characteristics: identification number, name, county, latitude and longitude, ownership, Carlson Trophic State Index, Lake Use Index, water quality trend, use level, fishable and swimmable goals, and causes and sources of impairment. By including these details, the IEPA has assembled the most thorough and efficiently organized report of any Region V state.

The report lists both public and private lakes. Significant public lakes appear to be those larger than 20 acres, but the tables include some lakes as small as 2 acres.

2. Use levels:

The report indicates whether or not specific lakes meet goals for fishing or swimming use, even if such activities are not conducted in the lake. Other uses are also taken into account, such as aquatic life use, water supply and general recreation. The Lake Use Impairment Index takes into account impairment levels for each use as well as trophic status.

Only 2.7% or the state's lakes fully meet all uses, but another 11.2% meet them and are threatened. About 29% do not support their uses, and the remainder are partially supporting. Criteria for determining use levels are explained.

Use levels are listed for individual lakes as well as on a basin and statewide basis.

As called for in Sec. 314, lakes are also classified by impairment status.

3. Pollution control approach:

The report details Illinois' pollution programs including staff and volunteer monitoring, permitting, lake management, and restoration efforts. The potential impact of Sec. 314 funding is also emphasized. With such funds, the IEPA plans to increase monitoring for toxics, conventional pollutants, and eutrophic indicators.

The IEPA uses both voluntary and agency monitoring programs to collect data on about 420 Illinois lakes. The information is used to rank lakes for restoration efforts through a lake classification system.

Federal Clean Lakes Program funds have been used in four completed restoration projects. Additional feasibility and implementation work is being carried out with 1987 funds in three lakes.

The state Water Quality Management Plan links lake improvement efforts to NPDES permitting, construction grants and other point and non-point source activities. Non-point controls are emphasized as soil conservation projects have been undertaken in 64 watersheds.

By requiring inter-agency review of any fill, dredging or shoreline modification activities, the IEPA sets the stage for regulatory coordination.

4. Acidity and toxics mitigation:

IEPA monitors accumulations of toxic chemicals in fish tissues at 20 permanent lake stations. Among the monitored pollutants are PCBs, dioxins, pesticides, mercury and other metals. Sediment samples from 26 lakes have also been analyzed for toxics. Determinations of elevated accumulations stem from comparisons with data collected in 1979.

The most prevalent heavy metal is cadmium for which highly elevated sediment levels were found in 14% of samples from half the assessed lakes between 1983 and 1987. Six percent of the lakes had highly elevated levels of PCBs, and four percent had similar levels of chlordane and heptachlor.

Pollutants in the water column are not separated by lake or stream, and thus waterborne contamination of lakes cannot be described alone. However, for all water column samples, copper, cadmium and zinc were the only metals with levels higher than standards for water quality use. Pesticides showed higher concentrations in the spring, presumably when rain occurred after pesticide applications. For priority organics, PCBs are the most highly detected pollutant. It was found in 32% of the samples.

5. Water quality trends:

For waterbodies with more than three years of data, trends in trophic status and other unidentified parameters are listed in the tables as stable, improving, fluctuating or declining. A majority of those assessed appear to be fluctuating, an indication that data do not indicate a trend. Determinations of declining water quality appear more often than do those for improving quality.

6. Compliance with Sec. 314:

The Illinois report appears to meet all of the Sec. 314 requirements. Its narratives are comprehensive, and the tables provide extensive information about each assessed lake.

Aside from completing assessments for all of the state's lakes, the IEPA could more fully meet the requirements by including a discussion of control strategies for toxics.

## Indiana

### Summary

Information about Indiana's lakes is spread through portions of the 305(b) report and a separate document, Indiana Lake Classification System and Management Plan. The 305(b) gives a statewide overview of Indiana's lakes, their trophic status and their uses. It also describes the state's monitoring network which keeps track of a variety of water quality parameters as well as contaminants in fish tissue and sediments.

Originally written to evaluate lake assessment efforts and provide a planning basis, the management report describes the development of lake analysis measures. It considers groupings by biome association and compares the commonly used Carlson trophic index to the more comprehensive Bonhomme trophic index. The report notes that statistical analysis shows poor correlations between the Bonhomme index and the Carlson measure. While further work may be necessary to verify the findings and their significance, the report calls into question the accuracy and usefulness of the Carlson system.

Using points determined by the Bonhomme system, the report sorts lakes into one of four classes corresponding to their trophic status. Out of 404 natural lakes, 19% show oligotrophic or mesotrophic characteristics, and 36% are mesotrophic to eutrophic. Another 17% are clearly eutrophic, while 29% may be classified more appropriately as wetlands.

For management purposes, the report describes a classification framework which divides lakes into seven groups and twelve subgroups. These categories reflect trophic status, mean depth and use. Specific strategies for maintaining uses and improving water quality are associated with each group.

1. Lake identification and description:

A total of 405 out of Indiana's 560 public lakes are included in a table characterizing them by nine criteria: location by name and county, trophic status, size, maximum and mean depths, total phosphorus, Secchi disc depth and management group. Watersheds are not described, although the river basin narratives include some discussion of land use.

Lakes are not identified by use status, sensitivity to acidity, or impacts from point and non-point sources. However, two lakes, Wolf Lake and Decatur County Reservoir, are listed as candidates for the 304(l) short list. Both are impacted by non-point source pollutants.

No definition is provided for significant public lakes included in the assessment.

2. Pollution control approach:

The management plan sets forth a proposed framework for regulating impacts to lakes. By clustering lakes according to size, mean depth and trophic status, the plan could lead to regulatory strategies tailored to each group. The document does not indicate whether or not parts of the plan have been implemented.

In 1986, the state legislature created a lake enhancement program in the Indiana Department of Natural Resources. Funded by a cigarette tax increase, that effort undertakes restoration effort too small for the federal clean lakes program.

The 305(b) report briefly mentions programs for regulating erosion, phosphorus in detergents, and weed removal in lakes. It is not clear how each of these efforts fits into management strategies at the watershed or state level.

3. Acidity and toxics mitigation:

The IDEM considers Indiana's lakes to be well buffered by the state's limestone bedrock (305(b), p. 154). Acid rain is thus not considered a problem, although some local areas could be sensitive. The state is participating in efforts to analyze the relationship between air and water pollution.

The IDNR regulates acidic mine drainage, but restoration efforts have been slowed by a lack of federal funds.

Indiana monitors accumulations of toxic chemicals by sampling fish tissues and sediments in areas of suspected contamination. In addition to Lake Michigan, the report identifies nine lakes as having elevated levels of toxic chemicals in sediments. An additional 22 lakes and reservoirs were sampled in 1985 and 1986. No strategy for removing toxics is discussed, although the 305(b) report notes (p. 44) concerns over suspending additional chemicals in the water column. As a result, the present strategy is to leave those sediments alone.

Of the state's 106 monitoring stations, all are on rivers except for five on Lake Michigan and one on Wolf Lake at Hammond.

4. Water quality trends:

The management plan states that most of the state's lake problems stem from cultural eutrophication, and the 305(b) report presents information (pp. 60-66) about trophic status trends in 31 lakes and reservoirs. The analysis shows that from the mid-70s to the mid-80s, trophic index numbers for 18 lakes went down, some significantly, and the indices rose or stayed the same for the rest. Variations in trophic status from year to year or even within the same season throw significant uncertainties into the assessment, but reductions in some indices are bolstered by associations with land use changes.

Despite the improvements, the IDEM estimates that 30% of the state's lakes and reservoirs measurably aged during the decade. The agency calls for additional efforts to curb non-point pollutants and combined sewer overflows. All lakes in the state, it adds, are threatened to some degree, and increases in nutrient loadings from any source would speed that process.

Trends for toxics detected in fish tissues show declines in PCBs, chlordane and dieldrin.

5. Compliance with Sec. 314:

The 305(b) report and the management plan largely meet the requirements set forth in the 1987 Clean Water Act amendments. To comply fully, the IDEM would have to do the following:

. Define lakes to be included in the report, possibly by size or public access, and pinpoint them by latitude and longitude. (The management report notes that this has already been done. Data may simply have to be included.)

. Describe the state's restoration program and efforts that could be carried out with federal agencies.

## Michigan

### Summary

The 305(b) report submitted by the Michigan Department of Natural Resources thoroughly describes the state's lake management efforts and meets the requirements of Sec. 314. The agency has assembled tables listing lakes by trophic status, impairment level and use.

It defines significant lakes as those larger than 50 acres with a public boat launch facility.

It discusses restoration projects, assessments of acid sensitive lakes and goals for new monitoring projects aimed at toxics assessment and water quality trends analysis.

While the report addresses all of the Sec. 314 elements, its table organization is somewhat cumbersome. For example, it uses 10 separate tables, in addition to the 304(l) lists, to describe lakes by trophic status, public access significance, pH levels, and impairment status. Efficiency and clarity would be served by consolidating this information.

Data gaps are appropriately identified. The report notes that a lack of adequate monitoring data precludes a broad analysis of water quality trends. While the state has regulatory standards for toxics control, the extent of accumulations of such pollutants is not well known.

1. Lake identification and description:

The report lists 673 publicly owned lakes of which 656 are identified as significant. In tables, the report lists lakes by size, county, Carlson trophic index number, watershed, and levels for use support, assessment, and impairment.

Altogether, 34% of Michigan's lakes are listed as eutrophic. Most are located in the southern portion of the lower peninsula near farmland and major cities. A total of 55% are listed as mesotrophic while another 12% are oligotrophic.

2. Use levels:

The report categorizes lakes as fully supporting, threatened, partially supporting or impaired. The uses cited are cold or warm water fishery and recreation. The use attainment level is determined in two ways: by observation of actual uses and by monitoring for water quality violations.

In a separate table, the report also summarizes use attainment statewide by both acres and numbers of lakes. It appears that more lakes are used for the statewide summary than are listed in the tables.

Of the publicly owned lakes, 299 (44%) are listed as impaired with either non-support or partial use. Another 172 (26%) are listed as threatened, and 202 (30%) are fully supporting.

3. Pollution control approach:

Michigan law regulates four pollution sources that affect lakes: point sources, construction activities, dredging or filling below the high water mark, and activities in which wetlands are dredged or filled or affected by construction. Permits are issued by different authorities for each with varying levels of state involvement.

Standards for water quality are described for a variety of parameters which reflect different pollution sources.

Monitoring activities in the past have been carried out through the state's voluntary "Self Help" lake monitoring program as well as through the MDNR's lakes management unit. The voluntary program involves riparian landowners who take chlorophyll-a and Secchi disc transparency measurements and share them with the MDNR. The cost and frequency of the readings are not listed, although the report notes that because of budget cuts, only Sechi disc readings were done after 1983.

Lake management staff last updated monitored data in 1982 but are using federal funds to sample 60 lakes in 1988.

4. Restoration efforts:

Lake Improvement Boards, authorized by Michigan law in 1966, have undertaken locally funded restoration projects focusing on dredging, weed control and aeration. In addition, federal Clean Lakes Program funds have been used for two large scale restoration efforts. The report describes both.

5. Acid deposition and toxics mitigation:

The report summarizes the results of the 1984 National Surface Water Survey for acidic lakes. Most of those sampled are located in the western portion of northern Michigan, and that effort concluded that 30.7% of surveyed lakes had a pH below 6.0 (p. 77).

Mitigation activities directly affecting lakes have been limited to demonstrations of adding lime as a temporary buffer against acid rain. That practice has not been proposed on a general scale.

Michigan's basic approach to acid rain has been to reduce the amount of sulfur dioxide emissions from stationary sources.

Discussion of the extent of toxics contamination is limited to concerns over mercury mobilization by acid deposition and cases of lake contamination with mercury and PCBs. Control strategies are not discussed. The results of a Michigan State fish tissue survey in 49 upper Michigan lakes have not been released.

6. Compliance with Sec. 314:

The Michigan report largely meets the requirements of Sec. 314. The MDNR lists a large number of lakes by appropriate characteristics and describes pollution control programs. Standards for use attainment determinations are clearly described. In addition, many data gaps are identified.

As currently planned monitoring projects are undertaken, additional data will be available for trends analysis and toxic assessments.

## Minnesota

### Summary

The Minnesota Pollution Control Agency (MPCA) weaves extensive lakes information into its 305(b) report but does not address Sec. 314 explicitly. In two separate tables, the report lists lakes by location, name, size, trophic status, level of use support, alkalinity, and sources of impairment. In the narrative portions, it addresses pollution control programs, inter-agency restoration efforts, and concerns over acidity and accumulations of toxic chemicals.

A total of 1,408 lakes (42% of lake acres) are included in the report, more than for any other Region V state. Significant public lakes, however, are not defined.

Water quality trends over a 20 year period are discussed on an ecoregion basis. While problems with such an analysis are noted, the discussion provides the most detailed consideration of trends in any of the state reports.

Pollution control programs are explained in detail at several levels. Monitoring programs include both volunteer and staff efforts, and assessments for both acidity and toxics have been carried out statewide. A variety of restoration projects have been carried out with federal Clean Lakes Program funds.

Overall lake quality varies significantly by ecoregion.
While most of the lakes in the heavily farmed areas, the Western Corn Belt Plains, the North Central Hardwood Forests and the

Northern Glaciated Plains are eutrophic or hypereutrophic, about two-thirds of those in the Northern Lakes and Forests are mesotrophic or oligotrophic. The remaining third are eutrophic.

Swimming uses follow that pattern. While most NLF lakes are partially or fully supporting, lakes in the other three regions generally do not meet goals for swimming.

While the four waterbody specific tables provide extensive details, much of the data is repetitive and could be more efficiently organized into one or two tables.

1. Lake identification and classification:

Lakes are identified by a variety of features (identified above) and classified according to both swimming and fishing use impairment and ecoregion. The basis for these determinations is clearly explained.

2. Use levels:

Lakes are listed by their status as fishable or swimmable. All lakes are designated for these uses, but use impairment varies by ecoregion. Use impairment correlates with the extent of agricultural activities.

3. Pollution control approach:

The report describes overall control strategies for point and non-point sources. In addressing lakes, the MPCA has used federal funds in nine Clean Lakes Another 17 projects are underway. Among the activities included are dredging, hypolimnetic aeration, biomanipulation and treatment of sediments. Current efforts focus on watershed management through the Clean Water Partnership Program. Other efforts include citizen and staff monitoring, education, phosphorus discharge permitting, and monitoring for accumulations of toxic chemicals. A strategy for controlling those accumulations is currently under revision.

The MPCA lists efforts to assess mercury contamination of fish tissue as a special state concern. An inter-agency research effort is currently underway to monitor acid rain impacts, analyze sediments and geologic conditions, conduct mass balance studies for mercury movement and continue fish tissue analysis. That effort is due to be completed in June, 1989.

Controls are also being developed for dioxin and furan discharges to surface waters.

4. Acidity and toxics mitigation:

No mitigation projects are listed for lakes affected by acid deposition or accumulations of toxics. The report notes that none of Minnesota's lakes are considered "culturally acidified," although 115 lakes are listed as threatened by low pH.

Research on controls for toxics are is discussed above.

5. Water quality trends:

Statistically derived water quality trends are discussed in detail on an ecoregion basis. Among the difficulties cited with the analysis are differences in detection limits over time and a lack of data for some parameters. Still, taken together, they show improvements in transparency and fecal coliform contamination. A significant increase in total suspended solids for the Red River basin is correlated with patterns in total flow.

The report also indicates that pH has been rising (increasing alkalinity) for all regions but the northern wetlands and the metroplitan area, areas for which data are lacking. No possible causes for this change are suggested. Still, 1,075 lakes have been assessed for acid sensitivity, and 115 have been classified as fully supporting (uses not identified) but threatened.

The trends analysis looks at changes in ten water quality parameters but does not correlate them with point or non-point sources.

6. Compliance with Sec. 314:

The MPCA does not address Sec. 314 in a straightforward manner, but the information in its 305(b) report meets most of its requirements. The agency has adequately identified lakes by trophic status and use impairment, and it describes its monitoring, permitting and inter-agency restoration projects in detail.

Areas of least compliance include control and mitigation efforts for acidity and toxicity. Since both these areas are on the forefront of current research, little information may be reportable at this time.

## Ohio

### Summary

The OEPA has addressed Sec. 314 by submitting a "Lakes Volume" with its biennial 305(b) report. The document summarizes the current state of regulatory knowledge about Ohio's 417 publicly owned and 301 "significant" public lakes. Significant lakes are those larger than five acres and freely open to the public. The other 116 have restricted access.

Using new surveyed information and monitored data collected between 1975 and 1982, the OEPA developed an index by which to measure water quality and level of use attainment. The index provides a clear basis for lake classification by fishable or swimmable uses. The Lake Conditions Index (LCI) uses 13 parameters, ranging from macrophyte growth and fish tissue contamination to the presence of priority and non-priority chemicals. The parameters can then be used to determine appropriate use levels for fishing, swimming and water supply purposes. A lack of data for fishing use precludes a comprehensive listing for that category, but 169 lakes totaling 100,259 acres (p. A-4) are categorized by swimming use.

The LCI is used to determine the impairment status of those lakes assessed for particular parameters. Very little data exist for fish tissue and sediment contamination, but 185 lakes have been assessed for aesthetics, and 166 for nuisance macrophytes.

Sedimentation impacts have been assessed on 164 lakes and nutrient and productivity levels on 125.

Although Ohio does not have a lakes program (p. 3), it does have a policy on point discharges to lakes and conducted an assessment of non-point impacts to meet the CWA Sec. 319 requirements. The OEPA's Office of Planning has also carried out four Phase I projects in coordination with the federal Clean Lakes program. The Lakes Volume addresses all of the Sec. 314 requirements and identifies areas of non-compliance.

1. Lake identification and description:

The report identifies the 417 publicly owned lakes by size and county. Other characteristics, including trophic status, will be included in the final report.

2. Use levels:

The Lake Conditions Index is used to classify lake use levels for each parameter. Full use reflects no impairment from that particular characteristic. Partial use reflects some impairment, while non-attainment means that use is impaired over a specified level.

Nearly half of the lakes assessed for weed growth have partial use, and one lake is considered impaired, a designation meaning that over half its shoreline has weed problems. A total of 92 are not impaired by weeds, and 251 are not assessed.

Only two of the 185 lakes assessed for aesthetics are considered impaired. This largely subjective condition is reflected in the levels of algae growth and obnoxious odors. A total of 99 lakes have partial use because of such concerns, while 84 are not impaired.

Data for sedimentation impacts are considered outdated since most of them were collected before 1980. All of the data are thus listed as "evaluated." A total of 144 lakes are considered partial use because sedimentation has caused a loss in volume. A total of 15 have full use, while five are considered impaired. 253 lakes were not assessed.

For nutrient levels, 33 lakes are considered eutrophic and 29 hypereutrophic. Another 34 are listed as having partial use, but it is not clear how that use level relates to trophic status. A total of 29 have full use, a category reflecting oligotrophic or mesotrophic status.

The number of eutrophic lakes increases when based on chlorophyll-a measurements. A total of 48 lakes are considered eutrophic and another 43 are hypereutrophic by that standard. 19 have partial use and 15 are considered full use.

Use levels for fewer lakes are also listed for non-priority pollutants, priority organics, priority metals, sediment contamination, fish tissue contamination, fecal coliform bacteria, and acid mine drainage.

A separate table compiles similar data for "significant" publicly owned lakes.

For swimming use, the report lists six lakes as non-attaining, 113 as partial, and 43 as threatened. Only seven lakes are listed as having full swimming use.

3. Pollution control approach:

Since Ohio does not have a formal lakes program, there is no coordinated framework for addressing lake management outside the federal Clean Lakes Program. The state has received federal grants to conduct restoration efforts on four lakes.

The state has policies setting "anti-degradation" as a statewide water quality goal and restricting new or expanded point source discharges to lakes. Implementation of those policies is not discussed.

For monitoring of toxic chemicals, Ohio has a Toxic Substance Control Strategy which outlines guidelines for the development of water quality recommendations. That document is not part of the 305(b) report.

4. Acidity mitigation:

The report identifies two lakes impaired by acid mine drainage and 17 additional public water supply lakes potentially affected. The Ohio Department of Natural Resources has conducted acidity mitigation projects on the two impaired lakes. A total of 98 lakes out of 100 assessed are listed as full use on the basis of acid mine drainage.

The report does not address the mobilization of soil based metals by acid runoff or the impacts of acid deposition.

5. Water quality trends:

The report notes that a lack of data prevents an analysis of trends in lake water quality. Nevertheless, information collected as part of the non-point source assessment indicates the presence of pesticides in 27 lakes and priority metals in 26.

6. Compliance with Sec. 314:

The Lakes Volume identifies current information about Ohio's lakes and assembles it in a clear manner. It also identifies gaps which need to be filled if the state is to fully comply with the Clean Water Act and USEPA guidance. Those gaps include the following areas:

. A description of each lake by trophic status (expected in the final report).

. An effort to collect data for a trends analysis of public lakes.

. A description of state point source policy implementation activities as they affect lakes.

. A description of lake restoration activities with appropriate federal agencies.

. A description of the acid drainage restoration efforts carried out by the ODNR.

# Wisconsin

## Summary

Extensive information about statewide lake assessments and research projects is incorporated into Wisconsin's 1988 305(b) report. The report does not directly address the requirements of Sec. 314, but it does address subjects relevant to them. The report also notes that the state is applying for grant money with which to meet 314 requirements.

Among the topics addressed in 305(b) are statewide overviews of lake trophic status and lakes with low dissolved oxygen levels (tables for these parameters are reprinted from the 1986 water quality report). Research on acid sensitivity and an acid mitigation project are discussed, as are projects intended to restore lakes overloaded with nutrients from point and nonpoint sources.

In 1986, Wisconsin established a lakes management program, an element of which is the long-term monitoring of 50 lakes statewide. Pollution control programs include WPDES permitting for point sources and the priority watershed program for nonpoint sources, primarily agricultural runoff.

1. Lake identification and description:

The report does not identify individual lakes for trophic status or location, even though it notes that a remote sensing program studied nearly 3,000 lakes for trophism between 1979 and 1981. Extrapolations based on that effort estimated that Wisconsin's lakes fall into the following categories: 21% oligotrophic, 26% oligo-mesotrophic, 26% mesotrophic, and 27% eutrophic.

A total of 96 lakes are included on the 304 long list of polluted waterbodies, but they are not described with respect to location, trophic status, or other characteristics.

The nonpoint assessment lists 1,084 lakes sensitive to NPS impacts. That list does include county, watershed size, volume, mean depth and flushing characteristics. The 303(d) list also lists lakes whose water quality is considered threatened.

2. Use levels:

The report addresses use levels statewide but does not define "designated use." A table reflecting use and assessment levels is currently being revised.

3. Water pollution control approach:

In addition to WPDES permitting and the nonpoint pollution abatement programs, Wisconsin has established a separate lakes program. The program aims at long term monitoring, public education and a variety of research and demonstration projects. The DNR has chosen 50 lakes and reservoirs as monitoring sites in order to evaluate trends in water quality. The report lists the sites chosen.

Among the research projects underway is an effort to determine if rainfed acidified lakes can be modified by pumped inflows of groundwater. In addition, water quality problems in many lakes (among them are Devil's Lake, Rice Lake, Squaw Lake, Lac LaBelle, Delevan Lake, and Bass Lake) are being addressed in cooperation with local authorities.

The WDNR hopes to update its statewide lakes assessment to meet the requirements of Sec. 314. Present data include too few lakes to provide a basis for a statewide assessment.

Wisconsin has had a nonpoint pollution control program since 1978, and 32 priority watersheds have been selected for the installation of new land use practices. The program is currently undergoing a legislatively mandated restructuring. Responsibility for watershed projects will be shared between the WDNR and the state Dept. of Agriculture, Trade and Consumer Protection.

4. Acid sensitivity and toxics mitigation:

As mentioned above, the WDNR is conducting research on lake impacts from acid rain. The agency believes that two to three percent of lakes, all in the northern part of the state, have been harmed by acid rain, and that many more lakes, possibly as many as 1,000, are threatened. Among the suspected impacts are increased mercury mobilization and accumulation in fish and waterfowl tissues.

The groundwater pumping strategy is the agency's only lake specific mitigation effort at present. Liming is rejected as a temporary strategy which detracts from attempts to solve the problem at its source. Point source reductions of sulfur dioxide comprise the state's major mitigation effort. Wisconsin utilities are reducing emissions by using low sulfur coal.

Efforts for toxics monitoring focus on fish tissue and sediment analysis. The WDNR issues yearly public advisories on PCB and mercury contaminated fish populations.

Toxics management activities for inland lakes are being developed through a research project at Little Lake Butte des Morts. The extent and impacts of PCB contamination are being studied with a mass balance approach to quantify loadings, transport patterns and downstream impacts.

Water quality standards for discharges of toxics are currently being developed.

5. Compliance with Sec. 314:

Wisconsin's report does not address the Sec. 314 requirements directly. Although the subjects mentioned above meet some of the requirements, the report falls short of meeting significant elements. To meet them, Wisconsin must:

. Identify lakes individually by trophic status, location, pollution causes and sources, use attainment levels and sensitivity to acidity.

. Define lakes included in the report and, if necessary, define "significant" public lakes.

. Describe restoration efforts and coordination with appropriate federal agencies.

## FOOTNOTES

[1] Persson, Lynn A. et. al, 1983.

[2] P. 33, Minnesota Nonpoint Source Pollution Assessment Report.

[3] P. 3, Ohio's Water Quality Inventory, 1988 305(b) Report.

[4] P. 20, Wisconsin Water Quality, Report to Congress, 1988.

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